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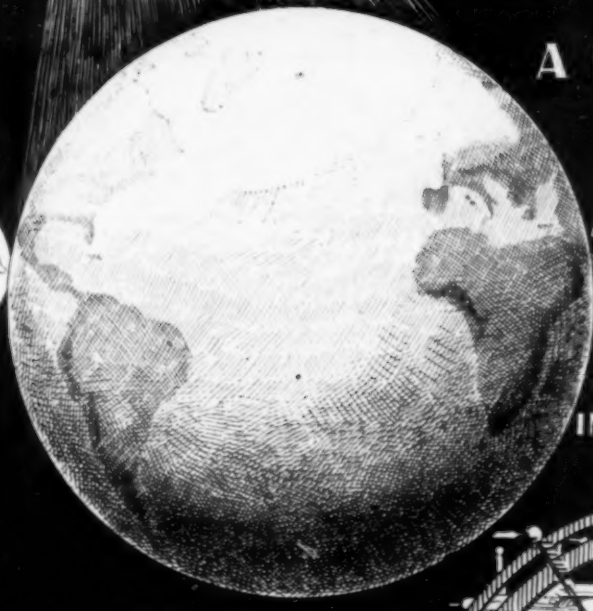
# THE AMERICAN X-RAY JOURNAL



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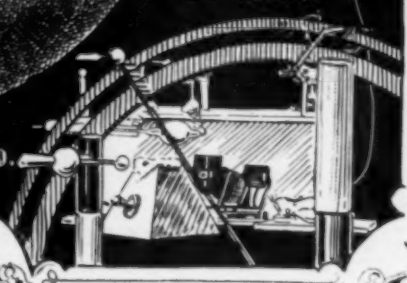

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## X-RAYS AND ELECTRO-THERAPEUTICS IN LONDON.

Editor AMERICAN X-RAY JOURNAL.

In the first section of this letter I wrote chiefly of apparatus and am obliged to say that if a delegation of ten of our leading U. S. makers should come here to inspect goods in their line they would want to hurry home to export a stock and drum up English trade. Many here are utterly oblivious of the fact that superior apparatus exists. A salesman in an immense house yesterday showed me some x-ray screens advertised in the *Lancet* (reading notice) to "give far better definition than any others." I would not buy until I examined one with a tube and when I remarked that it was only a very ordinary screen, &c., he seemed astonished to know that we had screens in America at all, and asked where we got them. He was much surprised to learn that they were neither English nor German, but were made in the United States. In some quarters I have found the same wonder about tubes. On the whole, however, it is probably correct to say that the *best* English coil, screen and result is nearly equal to the best American. The expert Londoner, however, can not appreciate the minor differences in our working method and would at first find our ways as awkward as we may think his.

In x-ray results the two countries are not far apart at the top. Good definition is obtained with short exposures by the best men I have seen here.

There has been for some time a desire to catch on the sensitive film the outline of stone in the kidney, and much quiet effort has been made to overcome the difficulties. Some cases are reported in print but they are very few. Three operators here have each been able to show me prints of *one* successful negative. Dr. —— made his 18 months ago and has never duplicated it. Dr. —— has also tried "dozens of cases of supposed renal calculi", and has one print to his credit, out of the lot. The histories of two published cases show the great value of x-rays in this direction if they can

be made positively to show that stone does or does not exist. The detection and localization of pieces of steel, &c., in the eye is now reduced to an accurate process by a London ophthalmic surgeon, Mr. Mackensie Davidson, to whom I am indebted for much courtesy. Probably no one in England is his superior in fine and scientific work. In due time he will publish his own researches and it would be out of place for me to anticipate him.

Deep parts and the pelvis still perplex operators here. Definition of soft parts is obtained to some extent but can not be assured in advance. In general it may be said that we are working along parallel lines and I see little here that I had not heard of in America. But a few things that were written up in our home journals as long ago as 1896, and which I had neglected in my own experiments, have been here actually seen by me for the first time. The best large prints I have seen were three made by a private gentleman of means for his own amusement.

Some surgeons are beginning to demand an exact localization of such foreign bodies as bullets, needles, &c., before they operate, and for this purpose a "cross-string localizer" is available, but as yet too little used. It was introduced here in the winter, by Mr. Mackensie Davidson, yet is only just made for the market. Without a copy of the X-RAY JOURNAL, of last summer (1897) at hand I can not recall how it differs from the device then described by Dr. Scott. The apparatus, as devised and used by Dr. Mackenzie Davidson, costs about $45. A cheaper substitute of a somewhat different kind is made for from $14 to $20. These prices are so much less than the cost of the fluorometer that I fear there will be no adoption of the latter here. The string localizer is best used with a negative but can be used with a screen. Striking effects are also shown by x-ray stereoscopy, and one view of such superb pictures as Mr. Davidson kindly showed me is quite apt to spoil the eye for the usual flat print. The view is also an instantaneous localizer. The full detail of an x-ray picture can not be even guessed until it is seen in lifelike relief in the stereoscope. I recall the note of Elihu Thompson on this point as early, I think, as April, 1896, but have had no time to attempt the work myself. One sight of a good steoroscopic effect is, however, enough to make the observer enthusiastic.

I have carefully inquired in the best informed quarters as to x-ray work in Berlin. No one here has any knowledge of any recent advance in that city, and some assert that London is ahead of Berlin in that field. From what I see of apparatus which is probably employed in Berlin I am disposed to credit the statement that Berlin is not in advance. One gentleman who saw Prof. Roentgen himself not very long ago told me that Roentgen was not likely to add to his original discovery. Of one thing I can vouch from tedious personal experience during the last two months in London, to-wit: Reports of x-ray miracles are not always crystalized fact. I have heard of various wonderful things here and have traced them up at the cost of much time and effort only to discover that they were not correctly reported.

Those who have read my book on "Static Electricity in X-Ray and Therapeutic Uses," will easily understand my desire to see Guy's Hospital and its historical electric room. Guy's has a new electrical department and a very good x-ray outfit but the little room where Golding Bird, Addison, and Gull did their remarkable work is in an old ward now used for obstetric cases. It was empty when I saw it. The attendant did not know much about it but thought the old static machine was in

the *cellar*. In the modern room I found an old nurse who was better informed. She showed me a curious static machine made 7 years ago, a copy of the one that figures in the Guy reports. If Golding Bird had the patience to use such a de vice he deserves to be framed in history beside Job. At the foot of the machine stood an old platform—perhaps the original one. It was about 24 by 36 inches, placed on small porcelain knobs about an inch clear of the floor and had a top of sheet zinc, let in a frame of black painted wood with sharp corners. Across the street from Guy's is a large store dealing in surgical and electrical goods. I talked with two salesmen and neither of them had ever heard of a static machine and could not inform me of any dealer in London keeping such an article.

Americans who have heard so much of the Wimshurst machine will hardly be prepared for the facts I have since ascertained. *No dealer in England makes for stock and keeps for sale any static machines.* Mr. Wimshurst is not a shopkeeper. He is an electrical engineer in the consulting department of the Board of Trade and inspects certain parts of boilers and engines in ships. He is a courtly gentleman of about 65 years of age, lives several miles out of the city and only amuses himself by occasionally making a machine which bears his name. During a pleasant evening spent with himself and son I learned much that was new to me of the status of static electric ity in Europe. As we know it, the thing don't exist here. From time to time a machine, usually small, occasionally very large, is made to order for some one. It has an excellent foundation of plates, but has no means of therapeutic use and in general no one knows that it can be used therapeutically. There are a few exceptions to these rules but diligent effort failed to find a single machine in London equipped in a manner to permit me to give a clinical demonstration to one of my new found friends who was interested. However, it is within the bounds of possibility that my visit here may bring about a revival of static electricity in England. I bring home with me a miniature plate as a souvenir, cut for me by the hands of Mr Wimshurst in his own laboratory.

In other departments of medical electricity an American visitor looks in vain for the complete and extensive outfits required for all-round work. The alternating sheet current fills in some deficiencies in an excellent manner and is much used in local and general baths by the best operators here. A good galvanic battery is easily found in many quarters but I have seen no faradic battery that an educated American physician would use. Fine faradic work, therefore, is unknown here. I see no slow vibrators in use. Meters are quite different in appearance and electrodes are few. In fact, the electro-therapeutic outfit seems to lack much in completeness and the routine work done seems very narrow. Only one dealer keeps a stock and he is a branch of a large German house. He tells me that 2000 physicians make some small use of electricity in the British Isles, chiefly in a very small way. He has sold six cabinets in eleven years. No electro-therapeutic journal is published here and electricity has little professional support with the pen. Hence, his sales are mostly cheap portable galvanic batteries and small faradic coils. There are but three books on the subject published in England—the total aggregating about 800 pages. Such a variety of clinical work as many of our home physicians do could not be done here even by the best expert in London—for the narrow limitation of his apparatus would not permit it. Yet, there is some advance and hope for more. This is Farady's land and although renowned for conservatism, yet,

it seems as if the actual demonstrated merits of electric currents must some day lead to the employment of fine apparatus and must finally establish the repute of so practical and useful an agent as electricity. S. H. MONELL.

856 Union Street, New York City.

London, Eng., July 22, 1898.

## INJURIOUS EFFECTS OF THE ROENTGEN RAYS.

BY JOHN T. PITKIN, M. D

It is safe to say that no scientific discovery was ever received with greater rejoicing by suffering humanity than the enunciation by Professor Roentgen of the possibilities he had discovered that the x-ray possessed which could be utilized to photograph the living dense structures of the human body and thereby determine their physiological and pathological condition.

An army of scientific men including many of the medical profession hastened to become his disciples.

Static machines and induction coils or step up transformers of every conceivable size and description were suddenly very much in requisition.

An era of experimentation and investigation with x-rays galore was inaugurated, all of which was productive of many glowing accounts of what was seen and done through their instrumentality.

But this new variety or degree of light, too rapid in its rate of etherial vibrations to be perceived by the visual organs also failed to impress the nerves of tactile sensibility and thereby warn us of its dangerous and destructive qualities, consequently many untoward results have been experienced through which the serservices of the Roentgenian have been brought into disrepute and his great field of usefulness thereby unduly limited.

Many who have been exposed to the Roentgen rays have suffered as sequelae all conceivable varieties and degrees of burns. The loss of an eye, the detachment of an external ear, the sloughing of a lower extremity, alopecia of a large portion of the head are among the alleged injuries sustained and one exposure of the brain to the rays for a period of thirty-minutes at a distance of one and one-half inches from the tube was in all probability contributory to death.

Although not any one operator of the rays may even hope to determine all of their mysterious properties, still each by careful observation may be able to add a little knowledge toward the enhancement of their usefulness on the one hand and the limitation of their destructiveness on the other. It is in this spirit that the writer who has had an experience from almost daily employment since their inception, nearly three years ago, concluded to communicate the tabulated results of his investigations.

### DESCRIPTION OF THE X-RAY BURN.

Not any disagreeable feeling is experienced in the parts during the exposure, only a gentle breeze caused by bombardment of parts by the particles of electrified air repelled from the outer surface of the Crookes' tube. A period of incubation lasting from one to twenty-one or more days in which the parts functionate as usual and are devoid of discoloration or discomfort. Small erythematous spots with itching and dull pain deep seated become manifest, the redness extends, the pain increases in severity, is worse at night, and at times almost unbearable. The epidermis becomes separated from the derma by a transfusion of watery serum forming large blebs which coalesce, break down and discharge profusely. The epidermis desquamates layer after layer much as we can remove the outer coatings from an onion, the parts are much swollen, stiff, hot, angry looking, bleed easily and are very painful. If the fingers or toes are attacked the nails lose their brightness, as they grow out the line of demarkation between the new and old

texture becomes apparent. The stage of ulceration supervenes characterized by its indolence, severe pain and being usually devoid of suppuration, its depth depends upon the severity of the exposure and the vulnerability of the tissues, it may involve all of the subjacent structures even the bone participating in the inflammation. After several weeks or even months of chronicity, the parts very slowly repair, the destroyed parts are often regenerated and functional activity may be entirely restored but the new integument will be devoid of hair and hair follicles.

### TREATMENT OF X-RAY INJURIES.

Treatment is of little avail—showering the parts with cold water reduces the temperature and for the time mitigates the pain. A rubber bandage loosely applied will hasten repair and afford a little relief, a solution of cocaine muriate will benumb the nerves, slightly raising the parts afford relief, but if raised too high, the suffering is intensified. Hot applications augment the discomfort of the patient.

### THE CAUSE AND HOW TO AVOID THE DANGER.

If in accordance with the general consensus of opinion we concede that the rays in and of themselves are devoid of dangerous properties, that all of the bad results are attributable to the electricity unconsumed in their generation, it becomes obvious that as the x-ray can not be obtained without the electrical currents every precaution must be taken to keep the patient's body out of their field of operation.

In the atmosphere in the immediate neighborhood of every excited Crookes' tube two separate fields of force, the electrical and x-radial can be investigated, a portion of the former travels the dialectric air along the conductors to and from the tube, another portion which concerns us most is repelled from its exterior traveling a varying distance into space but incessantly tends to return to the generating apparatus by the path or paths of least resistance, this field of force constitutes the danger zone and can be explored by a floating feather or silken fabric which will travel through the areal electrical pathway. The x-radiance can be traced through this electrical field into the apartment by the aid of the fluoroscope, it will be observed to diverge from the deflecting target in the Crookes' tubes spreading out in a conoidal manner, rectilenear in propagation.

*X-ray injuries* may follow the employment of any variety of exciting apparatus but are by far more common from the unidirectioned than the oscillatory discharges, because the latter neutralizes its own potential with each pulsation in the immediate vicinity of the Crookes' tube, *i. e.*, has a smaller danger zone whereas, with the unidirectioned current the tendency is to select the patient's body as a path for a portion of the return flow.

*Employment of* the metallic grounded screen as recommended by Nikola Tesla as a protective measure is of extreme importance.* With the modern static machines capable of developing a pressure of several millions of volts, the employment of additional spark gaps increases the electrical dissemination, raises the resistance, developes amperage, increases the electrification of the patient and thereby adds to the danger.

Although it may seem paradoxical, the same strength of current from a large static machine delivering an electro-motor force of three million volts capable of causing severe x-ray injuries with the Crookes' tube attached, can be employed to bombard a patient's body placed directly in the circuit, after the tube has been removed, as a therapeutic proceed-

*See Electrical Review, May 5th, 1897.

ure, with only beneficial results, the skin may be reddened for a few hours immediately following the exposure, but no delayed impairment need be anticipated.

*Insulating* the body of the patient exposed to the x-rays, lessens his electrical transmissibility, and hence, decreases the danger.

Untoward results are in inverse ratio to the distance from the excited tube, the time of exposure and the efficiency of the apparatus—in other words the Crookes' tube, like the red hot stove, will not burn us unless we are brought into too close relationship therewith, but unlike the stove the excited tube will not warn us of its destructiveness and such manifestations are not immediate but delayed.

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X-RAYS AND LUPUS.—It is reported from Vienna that Dr. Schiff has successfully treated cases of lupus vulgaris by means of the x-rays. His process is to set up an independent inflammation in the lupoid area by exposing the part to a very intense radiation. So far, investigations into the germicidal effects of the x-rays have gone to show that their activity in this respect is not greater than that of ordinary light. But Dr. Schiff's result is not a germicidal one, and we know that inflammation, and even necrosis may result from exposure in certain cases, although we do not know the determining factor which leads to iujury in some cases but not in others under apparently similar conditions. It is not, however, altogether improbable that Dr. Schiff's results may be due to a direct germicidal action of the x-rays on the tubercle-bacillus. Light, we know, is deleterious to this organism, and Dr. Finsen, of Copenhagan has reported cases of cure in lupus by protracted exposure to concentrated light, so arranged that the ultra-violet rays predominated.—*British Medical Journal.*

## THE CAUSE OF THE EFFECTS PRODUCED BY EXPOSURE TO THE ROENTGEN RAYS.

BY ALFRED C. PRENTICE, A. M., NEW YORK.

When Dr. Wm. Konrad Roentgen discovered the x-rays he gave them this name because he did not know what they were, and the algebraic sign for an unknown quantity aptly signified his limited knowledge of their nature. It is significant that the name is still applicable. Dr. Roentgen's first reports were published in January, 1895, since which time scientists have eagerly crowded into this field of discovery. Much has been learned of the phenomena exhibited by the x-rays, but many difficult questions remain unanswered as yet by scientific facts. Very like the phenomena of electricity itself, the exact nature of which is still an enigma, the results produced by that form of electrical discharge in the vacuum tube, viz., the cathode rays and the x-rays, have found many new and varied applications in practical science, while many conflicting theories attempt to explain their action. Nor is the evidence brought forward as yet conclusive as to their exact nature.

The most important use of the x-rays is in medical and surgical diagnosis, but this has been involved with troublesome results in some cases. From their early use, and even now occasionally, there has followed a severe lesion at first apparently of the skin, but later involving the deep tissues as well. The constitutional disturbances have been most severe, and the process of healing is always protracted and exceedingly painful. Although cases of the "x-ray burns" so-called have become less frequent, and of the patients exposed to the rays, probably only a small fraction of one per cent experience any such results, nevertheless the uniform severity of the lesion and its obstinacy in healing can not but

qualify as more or less dangerous any exposure to their action. Notwithstanding these objections, the use of the x-rays in surgical diagnosis is destined to become general. Cases are on record (1) in which even the courts are required to accept the skiagraph as corroberative evidence of expert testimony.

The theories adduced to account for the injuries resulting from the application of the x-rays, inducing the "x-ray burn," have not as yet afforded either a remedy for the lesion or a way to avoid it.

The following series of experiments* have been conducted by the writer during the past six months in the study of the problem.

The x-rays were produced by means of the static electric current from a Wimshurst or influence machine having eight circular plates of blown glass each twenty-eight inches in diameter, revolvat a high rate of speed between an equal number of stationary plates. The power was supplied by an one-half horsepower motor of the Crocker-Wheeler type connected with the current used for lighting the building. The apparatus is supplied with Leyden jars, in circuit or not, accessory spark gaps, and all adjustments for perfect regulation to secure the best results from the vacuum tubes. The tubes used were fourteen inches in length, having each a bulb three and one-half inches in diameter, enclosing aluminum cathodes and platinum anticathodes, also provided with an auxiliary potash tube to be connected in circuit by a shunt, so as to reduce the vacuum when it became too high. In this manner the tubes could be so adjusted to the potential of the current as to produce x-rays of the greatest brilliancy and penetration, and maintain their uniform production for an indefinite period without danger of breakage by perforation.

Two guinea pigs kept upon the same conditions of food, etc., were used—one for the experiments and one for the purpose of normal comparisons. Exposed a pig to the x-rays at a distance of three inches from the tube for a period of twenty minutes in order to accustom her to the slight annoyances of noise, etc., incident to the following experiments.

The only effect of the exposure was a slight drowsiness, which gradually passed away. No further effects of the exposure became apparent during the following week. Accordingly the pig was again exposed to a low vacuum tube giving x-rays of a poor quality, at a distance of one inch from the surface of the tube, for ten minutes; and again to a high vacuum tube emitting intensely brilliant x-rays, at the same distance, for a period of two hours. During this time the pig was confined in a pasteboard box perforated by a window one and one-half inches square, directly opposite the pig's right lateral thoracic wall. She remained quiet in her box except at intervals she would shift her position as if uncomfortable, but would immediately return to her former position. Three or four times she appeared to act as if something annoyed her belly and endeavored to reach the spot with her nose, but after some slight effort subsided into quiet.

During this time the table on which the pig rested became strongly electrified, and no doubt the pig was electrified as well.

She acted entirely normal, and no cutaneous or other effects were noticeable for one week after the exposure.

The fur was then clipped from a region one inch square, over the right lateral thoracic wall, which had been previously exposed, and again submitted to action of rays of greatest brilliancy for a

*The experiments mentioned in this paper were conducted in the photographic and x-ray laboratories of the Department of Pathology in the College of Physicians and Surgeons, Medical department of Columbia College in the City of New York, under the guidance of Dr. Edward M. Leaming, F.R P.S., instructor in photography, photomicography and skiagrapny in the above institution. The microscopic data here presented were supplied by the courtesy of Dr Frederick S. Ward, assistant in Normal Histology in the Department of Pathology.

period of seventy minutes at a distance of one inch.

In this exposure, although neither the pig nor table came in contact with the electrical apparatus, both became so strongly electrified that a spark was produced between the edge of the table and my finger held near; and the pig started and squirmed when I touched her, as if pricked with a pin, while I could feel the pricking sensations at the tips of my fingers, on touching her body. By the end of the week from the time of this exposure, there appeared on the clipped area two or three dry vesicles of exfoliating epidermis. The lesion gradually grew deeper and continually worse, until at the end of the second week the animal was very ill, showing marked constitutional symptoms of fever and depression. Examination revealed a characteristic "x-ray burn." The skin had vesiculated and peeled off in flakes, leaving a pale, raw surface, moistened with serous exudation. Not much, if any, inflammation was evident, but the lesion was quite sensitive and apparently very painful. Only the small area which had been clipped was at first affected, but the injury rapidly extended, and on the night after the fifteenth day following the exposure the pig died.

On picking up the body by the fur at the back of the neck, a large bunch came out, permitting the body to fall. Body was dissected and portions were reserved for histological examination. The following is Dr. Ward's report:

*Examination of Injury to Thoracic Wall of Guinea Pig Due to Prolonged Exposure to Action of X-Rays.*

"*Macroscopical.*—Over a circular area of about four c. m. in diameter the hair and skin had been removed and the exposed surface was parched, the subcutaneous tissue and thoracic muscles feeling as though they were partially dried to the underlying ribs.

*Microscopical.*—Portion for examination taken through the seat of injury and including entire thickness of thoracic wall. Fixed in formalin five per cent; alcohol, ninety-seven per cent. Decalcified in acid. Imbedded in celloidin. Stained with Gage's haemotoxylin and alcoholic eosin. The skin and subcutaneous tissue had all disappeared. In the central portion the superficial layers of muscles did not stain. No striations were visible. The blood-vessels were shrunken and contained very little blood. Approaching the margin, the staining of the specimen improved, striations and cell nuclei of the connective tissue were visible. The deep, muscular layers of the central portion were slightly stained with eosin, and the nuclei took on a pale-purple color, but in neither case was the staining that of normal muscle. At the edge of the affected area, about blood-vessels and between muscles, there was a moderate amount of infiltration of small, round cells.

*Anatomical diagnosis* is that all the structures at the site of the injury have lost their vitality and have become dried. In the closely adjacent parts there is a very moderate amount of inflammation."

The sensation of drowsiness has been mentioned by other writers as following an exposure to x-rays. The statement of Professor J. J. Thomson that "all bodies traversed by Roentgen radiations become conductors of electricity" is perhaps a hint. It is supported by Professors Trowbridge and Burbank. (2) We know that twice were the animal and table charged in our experiments. Tesla states (3) that "by means of an enormous potential and high frequency, the tube was surrounded by a violet luminosity or halo," and that "Lenard also obtained a similar phenomenon in front of the aluminum window."

Mr. Rollin states (4) that the burning from vacuum tubes *not generating x-rays* may be severe, the tube being exhausted to such a degree that no Roentgen light could be produced with the voltage used.

Professor Thomson, of Harvard, demonstrates (5) by experiments upon himself that if the x-rays are ether vibrations of great rapidity, known as ultra-violet light, as we are now led to believe, they could not have produced the "burn" which he induced upon his finger by exposing at one and one-half inches distance from a vacuum tube of blue glass

in which was a transparent window of clear German glass, the injury which followed occurred only on that portion opposite the clear glass window, and the part covered, as it were, by the blue glass was unaffected, marked off by a sharp line of demarcation. He says the blue glass would have been transparent to the ultra-violet rays.

In another case (6) of purposely induced dermatitis, no effect was produced where the skin was covered with lead and tin foil, the lesion appearing only on the uncovered area, although exposed at a distance of only five-eighths of an inch. It would appear that only the electricity attacking the area covered by the foil was conducted away, while that attacking the uncovered area was the ultimate cause of the injury. Certainly the x-rays would have penetrated the foil as if it had been paper.

Dr. Monell is authority for the statement (7) that "nothing is more certain than that a sufficiently energetic electric current passing to tissues which it can reach and enter only after electrical energy has been transferred into heat by resistance, such as dry and hair-covered skin or clothing, will vesicate and can be made to produce intense and deep inflammatory action."

All these statements combined with the evidence of direct experiment tend to the conclusion that not the x-rays themselves, but the direct actions of the electric currents upon the fluids and tissues are the real factors in the damage done.

Tesla has stated (8) that he "believes the hurtful action is not due to the x-rays, but to the ozone generated in contact with the skin. Ozone," he says, "attacks the cutaneous surface, its action, no doubt, being heightened by the heat and moisture of the skin. This generation of ozone ceases at a definite distance from the electrical terminal, and the same is true regarding the production of this irritation." He also believes, or did believe that the electrodes became gradually disintegrated by the bombardment of the cathode rays, and that these metallic particles penetrate the walls of the tube. He said, (9) "I am getting more and more convinced that we have to deal with a stream of material particles which strike the sensitive plate with great velocities. If these observations be confirmed by men of keener insight, I shall be still more convinced that material streams of matter actually penetrate the skull. Thus it may be possible to project a suitable chemical into any part of the body."

Professor Ames (10) states: "The radiation in an x-ray tube may be divided provisionally into three classes: Ether waves, which may have wave-lengths from 150 to 800 m. m. approximately; cathode rays, which undoubtedly are streams of matter electrically charged; and x-rays, about whose nature there is no conclusive evidence at the present time. If the walls of the tube are thin enough, and of suitable material, all these radiations will emerge and pass into the surrounding air. It is a matter of doubt if the cathode rays observed outside the vacuum tube are the same as those inside; but the inner ones undoubtedly cause the outer ones. There is no evidence that the x-rays carry with them particles of matter, or that they directly cause a stream of particles; in fact, all known facts serve to point to the belief that they are ether waves of extreme shortness."

If this last statement holds true, then Professor Thompson has proven that the x-rays themselves do not burn. That the "cathode rays are streams of matter electrically charged," gives Dr. Gilchrist (11) sufficient reason to assume that the lesions may be due to the entrance of material particles—of platinum in his case—into the tissues, and that the cathode rays which accompany the x-rays, may be the cause of the trouble and not

the x-rays themselves. He endeavored to show that these particles had so accumulated in a given case as to produce an ostitis and periostitis, acting like foreign bodies in the tissues. He produced in evidence of this a skiagraph of the part taken after the injury was developed, which he said showed a marked increase in the density of the bones. He laid no emphasis on a chemical analysis of the exfoliated skin, which, however, gave a negative result.

Campbell Swinton, Esq., of London, writes: "Cathode rays are generally believed in this country to consist of atoms or molecules of risidual gas, which, being similarly electrified to the cathode, are repulsed by the latter, and travel at an average velocity not much less than one-twentieth that of light, the velocity depending upon the exact potential of the cathode and the molecule at the moment the latter leaves the former, and also upon the degree of the exhaustion of the tube, upon which depends the free path of the molecules, that is, the distance a molécule can travel without coming in contact with another molecule."

It seems strange that Dr. Gilchrist should have so confused the material particles of the cathode rays, which, as we have seen, can be nothing but residual gas, with the unique theory of Tesla, who spoke of metallic particles of the electrodes—aluminum or platinum, as the case might be—which he believed were projected through the walls of the tube and into the densest tissues. Tesla has also informed us (12) that if the part of the body exposed to the x-rays be placed between a metal plate and the tube, the injury would be on the side of the part on which was the metal plate. But that if a thin plate of aluminum, which is practically transparent to the x-rays, or a sheet of wire gauze, be placed between the tube and the exposed part, and at the same time the *metal screen be electrically connected with the ground*, the disturbance to the tissues will be avoided. His latest suggestion (13) is that it is possible for the "electro-static influence" which generates the ozone to "decompose the sodium chloride in the tissues, thus giving rise to irritants." It would appear that his statements of the violet halo or brush-discharge around the tube connected with the practical value of a metal screen in dispersing the injurious agents when electrically grounded, and its concentrative power, if placed on the far side of the part and not grounded, point directly to the action of electric currents and nothing else.

Dr. Charles a Lenard (14) states directly that the "burn" is the result of induced electric currents in the tissues, which will be induced capable of destroying their vitality, if the patient is approached sufficiently near to the x-ray tube.

Dr. Monell speaks of the "electrical energy transformed into heat by resistance of dry skin, etc., as causing dermatitis and inflammation. Professor E. Dorn (15) has demonstrated that x-rays do exert very slight heat effects, and he has measured their quantity, but this element is of so small amount as not to be appreciable.

A remarkable fact in nearly all cases of the "burn" is that no sensations of heat are felt at the time of exposure, and only in some cases is there noted any immediate symptoms whatever, as of "a sense of prickling heat, or a tingling followed by itching;" but there is uniformly no sensitiveness or pain. Another characteristic is the time which elapses from the exposure to the appearance of the first symptoms—usually a week to nine or ten days, or even a month or more in some cases. These facts have called forth the statement from several authorities (16) that the lesion is "not a burn," inasmuch as the accepted defini-

tion (17) of a burn is "an injury produced by the action of too great heat." It is also useful to note that ichthyol usually gives relief from pain in an ordinary burn, but Dr. Tuttle (18) found that it aggravated the pain of an x-ray injury. Cold water also proves soothing to burns, but in this case it was found the pain increased when moist dressings were applied of a temperature lower than 85 deg. Fahrenheit. Also, in certain cases, where skin grafting had been employed, the severe neuralgic pain still persisted after the part had healed.

It may not be improbable that electrical energy attacking the tissues is transformed into another form of energy than heat, as perhaps electrolysis of chemical substances. Dr. Bardeen (19) regards it justifiable to consider that one of the main causes of death after burns (ordinary) is to be sought in a toxaemia caused by alterations in the blood and tissues, the direct effect of the elevation of temperature; "a view which is further strengthened by chemical evidences and the experimental work of Kijanitzen and others." Since the pathological condition of the tissues in the "x-ray burn" correspond very nearly to, only are worse than those of a severe burn produced by heat, it does not seem unreasonable to suppose that similar chemical alterations and decompositions might be produced by electrical energy or electrolysis as are supposed to be produced by mere action of heat. Tesla hinted at this phase of the question in speaking of the decomposition of the sodium chloride.

It is well known that the static discharge in air produces ozone in a more or less considerable amount. The fact that a sufficient amount to detect by the odor is often produced and inhaled with impunity to the mucus lining of the respiratory passages would cast some discredit on the theory that it might irritate a warm and moist skin.

Tesla has demonstrated, however, that metallic particles of the anticathode do become deposited upon the inside of the tube, by breaking the tube and analyzing the deposit noticed. This deposit is especially noticeable in the tubes that have been in use for some time and at so high tension as to render the anticathode red or white hot. But whether these particles could penetrate the tube and enter the tissues to produce irritation as foreign bodies, is another question.

In order to test this matter, I exposed to the rays of maximum brilliancy four photographic plates superposed, so that if the metallic particles should strike the sensitive film or even pass through it, and one or more of the four glass plates and gelatine films, just as in human tissues Tesla supposed them to do, they would be apt to lodge, some of them at least, in one or more of the films. The exposure in this case was timed and adjusted exactly as in the last exposure of the guinea pig, viz., for seventy minutes at a distance of one inch. If the metallic particles caused the lesion which developed a week later in the case of the pig, they would certainly be deposited in the films of the plates. I therefore removed all the films, after having dissolved out the unchanged silver-salt in a solution of hyposulphite of sodium, and evaporated to dryness. Reduced the residue to an ash which was then digested in aqua regia (HCL, 3 parts to $HNO_3$ 1 part, concentrated), forming from any metallic platinum present, soluble platinic chloride, $PtCl_4$. I then treated this solution with stannous chloride, $SNCl_2$ which reduces platinic salts to platinous salts. The latter are soluble in dilute hydrochloric acid, (HCl) giving a characteristic deep cherry red colored solution. I accordingly added HCl, but no color reaction took place. At the same time, for a check test, I dissolved in 10 c.c. of water two or three small granules of potassium, chloroplatinite,

and tested for platinum, as already indicated. The color reaction was characteristic, intense and permanent, in fully 20 c.c. of solution. This experiment proves conclusively that the particles of platinum are not projected into surrounding objects.

It is of quite recent demonstration (20) that the silver salt of the photographic plate which is sensitive to white light, is not affected by the x-rays. Experiments made upon the sensitized collodion film and the Daguerreotype plate produced no image whatever, while upon the gelatin coated plate or film the negative image was produced in the usual manner.

The conclusion drawn was that the x-rays did not produce an electrolytic effect upon the silver salt, nor even the partial decomposition as produced by ordinary light directly; but they did produce a fluorescence of the gelatine film and perhaps of the glass support, if it were of a fluorescent material, which in turn acted upon the silver salt suspended in it, just as ordinary light does. Incidentally the statement was made that plates most sensitive to ordinary light are not necessarily most sensitive to the x-rays, since the result depends upon the kind of gelatine used, and the period of cooking to which the emulsion was subjected. This fact was apparently confirmed by a series of comparative tests conducted by the writer in which he was convinced that the particular brand of plates which happened to be cheapest in the market produced the best x-ray negatives in the shortest time of exposure.

Little attention has been given to the comparative value of the static and induced currents in the production of the x-rays, and it may be worthy of note in this connection that in the great majority of cases reported as "x-ray burns," the current has been generated by the induction coil apparatus. Such an equipment of high potential, even a ten or twelve-inch spark-gap, requires less room, and is less expensive; but the current is characterized by much greater amperage than the static current of the same or even greater potential in volts. The amperage of the static current is very low, while the potential is almost unlimited under proper conditions. Also the distance of the exposed part from the tube in those reports which mention the distance has been invariably small, from three or four to six or eight inches.

The length of the spark-gap is directly proportional to the internal resistance of the tube (21), and is also directly dependent upon the voltage (22), and not the amperage. The greater the internal resistance, the more penetrative are the x-rays produced. Thus it is seen the production of x-rays of the highest penetrative value is directly dependent upon the voltage utilized. And consequently, the lower the amperage, the less danger attends the use of the tube, because a less quantity of electricity per unit of time is free to act upon the tissues; and with a current of higher potential and lower amperage the greater may be the distance from the tube, and only the voltage is important to produce x-rays.

Since the intensity of the x-rays varies inversely as the square of the distance, it follows that the higher the potential in volts, the greater may the distance be, to produce the same results of penetration, I have not been able to see any penetration by the skiascope, from a tube supplied by an induction coil having a six-inch spark gap at a distance of eight feet. While with a tube supplied by the static machine working at a similar sparking interval, the bones of my hand could be seen at a distance of thirty-six feet.

Professor Thomson has already demonstrated that a "burn" may be induced by the use of the static current in the vacuum tube, but no cases on record, to my knowledge, in which injuries have

been sustained at so short a distance as six inches, using the static current, while one case I recall was burned by the induction current x-ray tube at a distance of eighteen inches.

If the intensity of the brush discharge is governed by the same law as other form of radiated energy, it would require an exposure of some thirty-two hours at a distance of twelve inches, and fifty-seven hours at a distance of sixteen inches, to produce a lesion as Professor Thomson did while using the static current in his tube for half an hour at one and one-half inches distant, making no allowance, of course, for idiosyncrasies of patients.

The radical treatment that has been employed consists in a complete excision of the lifeless tissues, as in gangrene, thereby producing a healthy granulating surface in the wound, which rapidly heals. One surgeon claims to have cured twenty-five or thirty cases by cutting down clear through the affected part, and then dressing with carbolic acid until granulation sets in. Balsam of Peru was then applied, and healing took place by granulation. Of course the necrotic tissues had to be sloughed off in this latter treatment.

In noting the conclusions of this paper it will be valuable to compare results strikingly similar of a series of experiments (23) by Oudin, Barthelemy and Darier, of Paris.

CONCLUSIONS.

1. The general character of the tissues affected in the "x-ray burn" is that of absolute necrosis and more or lesss exudative inflammation. The resulting alopecia is more or less marked in lesions involving hair follicles.

2. The x-rays themselves exert no appreciable heating effects, and consequently do not burn. All evidence seems to point to the conclusion that the lesion is due to the direct effects of the electric currents upon the tissues and fluids. The nature of this effect is as yet wholly speculative.

3. The ozone irritation theory is not supported by evidence.

4. Metallic particles of the platinum anode are not projected into substances near to x-ray tube.

5. X-rays do not decompose the silver salt of the photographic plate directly, but produce in the gelatine film a fluorescence which in turn acts upon the silver salt as ordinary light.

6. The use of the static rather than the induced electric current in producing the x-rays is less liable to result harmfully, (*a*) because it is of low amperage, and (*b*) being of very high potential comparatively, does not necessitate so short distance between the tube and the exposed part.

7. In all cases where exposure is required at a distance less than twelve inches from the tube an aluminum screen, electrically grounded, should be placed between the tube and the exposed part.—*Medical Review of Reviews*, N. Y.

121 West Sixty-second Street.

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THEORY OF ROENTGEN RAYS. Lond. *Elec. Rev.*, May 13.—Stokes suggested a theory several years ago, according to which these rays are aperiodic electromagnetic waves caused by the impact against the anti-cathode of the charged particles in the cathode stream; this theory was recently developed by J. J. Thomson (*Phil. Mag.* page 172). Lord Rayleigh, in *Nature*, April 28, protests against the acceptance of this theory, as it does not carry with it some of the consequences which have been deduced as the distinction between Roentgen rays and ordinary luminous and non-luminous radiation; he does not agree that Roentgen rays are not very short waves, but impulses; he favors the view that the waves differ from ordinary light only in the shortness of their waves.

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IF one wishes by a simple optical illusion to obtain an almost perfect imitation of the wonders of radiography, he may take a small turkey feather, and, holding it close to the eye, look through the radiating ribs at the end of the feather at the ends of the outstretched fingers of his hand, held against the window. This done, the flesh will appear to be transparent, with the opaque bone running down in the center as shown by true radiography. If gas light is used, a piece of ground glass must be held before the flame, to diffuse the light.—*Inter-Ocean.*

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CATHODE AND ROENTGEN RAY TUBES. Villard. *L'Eclairage Elec.*, May 28; *Electrical World*, New York.—An abstract of a French Physical Society paper describing improvements. One of these is an anticathode which does not blacken the tubes; iridium is very satisfactory if quite pure, but the commercial variety is not pure enough; the new anti-cathode is in the form of a paraboloid with a lateral opening through which the cathode rays enter; this will not blacken the tube, because it never acts as a cathode for the reversed currents; the form of the anode, creating an electrical field which is practically zero in its interior, totally prevents the formation of these new rays. He also describes a tube which may be regenerated; part of the tube consists of a small tube of platinum closed at one end and joined at the open end with a glass tube; nickel or palladium will also answer; to regenerate the tube this metallic tip is heated in a Bunsen flame; at about 1,000 deg., hydrogen passes through the platinum, but it is absolutely impenetrable to air. He also mentions some magic screens on which the images are preserved, but the description is not quite clear.

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TREATMENT OF LUPUS WITH ROENTGEN RAYS AND CONCENTRATED LIGHT.—Dr. Kummel (Hamburg) claimed that in selected cases these means were successful, but experience with them was yet too limited to absolutely state the indications and contraindications. He exhibited two advanced cases almost cured, in which he expected a continuance of the treatment to cure radically.

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TRANSPORTABLE X-RAY APPARATUS. Levy. *Elec. Zeit.*, July 7.—A reprint of a brief, illustrated paper describing a simple, portable apparatus, devised by him.

## ROENTGEN LIGHT NOTES.

BY WILLIAM ROLLINS.

NO. XXX—THE WAVE LENGTH DEPENDS ON THE TEMPERATURE.

In note VIII I stated that the wave length depended upon the velocity of impact. In this note temperature is considered. Fig. 30 shows a modification of the tube described and figured in the *Electrical Review* for December 1, 1897. There is a receptacle for a thermometer to show the temperature of the water escaping from the hollow target. If we keep this water at five degrees centigrade a higher voltage is required to produce Roentgen light of a given wave length than when the water has a higher temperature. On the other hand, by using a lower voltage or vacuum and increasing the number of impacts upon the target by increasing the amperage, we can make an uncooled target so hot it radiates ordinary light, and yet the tube will not yield a ray of Roentgen light because the force of impact is not great enough to heat the individual particles of the cathode stream sufficiently to produce the short vibrations which are Roentgen light. In practice a very high temperature of the target is not desirable, because the shock of impact of the rushing particles of the cathode stream on such a target is less violent and therefore less efficient in producing the enormous temperature of these particles which is essential. That we are unconscious of this temperature is simply because at present we have no means of producing such rapid vibrations in a sufficient number of particles to constitute a mass such as we think of as a source of heat. We can, however, by using a very high vacuum and voltage, produce a temperature perhaps higher even than our sun, one at which we can decompose some of the so-called elements which, at the ordinary temperatures, are gases, and here the vacuum tube opens a new world.

NO. XXXI—ON HAVING THE TARGET SEPARATE FROM THE ANODE AND NEARER THE CATHODE.

In Note XVIII it was said that the wave length depended upon the velocity with which particles from the cathode struck the target. As the force of this molecular projection at any point depends upon the rate of change in the potential, it is less at three inches than at a nearer point. Therefore when as shown in Fig. 2, Note XVI, the target is between the terminals, the velocity should be greater than when the target is the anode. By adopting this construction in two terminal tubes we should be able to take advantage of the high initial velocity due to the difference of potential we can maintain by having the terminals three inches apart, and yet by placing the target at one and one-half inches from the cathode, we should cause the molecules to strike it with a higher velocity than they would if they continued their flight to the anode and used this as a target. So with a given voltage we should be able to generate light of a shorter wave length or of the same wave length with a lower voltage. The latter is a matter of some consequence, as it should enable us to use a smaller generator. Another possible advantage is that the cathode discharge is more shielded from the anode rush described in notes XX and XXI. I have considered two terminal tubes only because this is the type in common use. Mr. Tesla's tubes described in Thompson and Anthony's work on x-rays, though a much more interesting form, are at present so rarely employed outside the laboratory of this great discoverer that I have never seen any of them except those I have constructed for my own use. One of these is shown in Figs. D and DI in previous notes in

the *Electrical Review*. This can be used either as a single or double terminal tube, though it was constructed to combine Mr. Tesla's single electrode with the Crookes' and Roentgen plan of bringing the cathode stream to a focus, and to these I added the cooled target. As the statement has been made that the wave length depended upon the voltage, it might be supposed that with the very high potential which can be maintained with such a tube it might not be suitable for generating light of the longer wave length required for distinguishing between the soft tissues of the human body; but this is of no moment, for it is only necessary to use a lower vacuum, thus making the wave length longer by diminishing the velocity of impact. It is practically impossible to get so high a voltage that we can not control the wave length by the degree of the vacuum, and when we can get it high enough we can realize the dream of many now working on this problem and discard the vacuum tube as an essential in the production of this light.

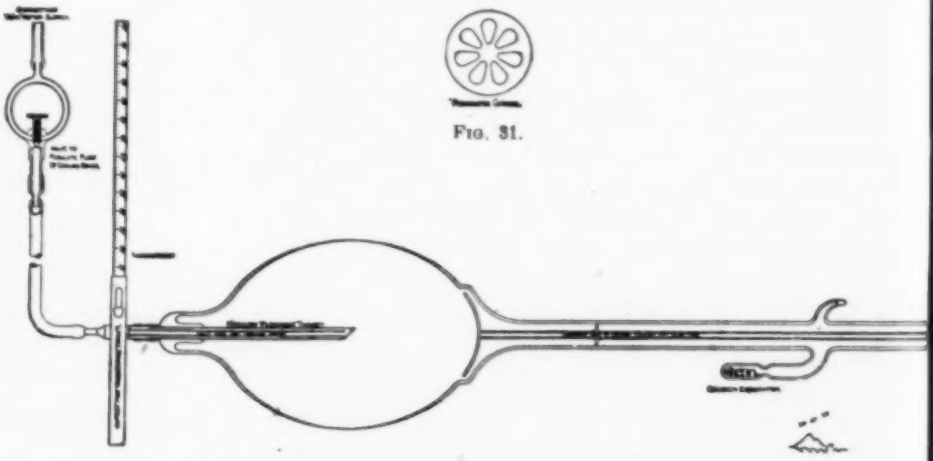


FIG. 31.

FIG. 30. (SCALE ONE-QUARTER.)—MODIFIED A-W-L ROENTGEN LIGHT TUBE.

NO. XXXII—ON THE SIZE OF CATHODES.

For Roentgen light to be of much use in medical diagnosis it is necessary to have a generator of sufficient power to send the light through the adult body at a distance of at least three feet from the radiant area on the target of the tube. Shorter distances produce marked distortion of the internal organs, a matter of grave importance in studying the heart and determining its real size in disease. This distortion is also a serious matter in estimating the relative sizes of organs lying in different planes, the one farther away being made to appear relatively too big. Six feet is a much better distance, but, unfortunately, there are no commercial generators powerful enough to furnish a proper light at this distance, and such an apparatus is necessarily expensive, costing $1,000 even when made at home. As three feet taxes the best commercial generators to their limit, it is necessary inusing the fluoroscope to economize power by sending the electric surges as slowly as is consistent with a steady light. Two hundred surges a minute are said to do this, but Dr. F. H. Williams and I find it necessary to have 1,200 a minute to have the illumination of the screen appear steady to us. As every surge must give force enough to properly illuminate the body, it is necessary to make each of as large an amperage as possible with the

generator employed. We do this by filling the condenser as full as we can in one-twentieth of a second, which is the maximum time we can allow force to accumulate for a single surge. When we attempt to deliver this amperage from a cathode of ordinary size the electricity seems to have difficulty in escaping from the concave side of the cathode in a normal manner. As a result we get the lateral sparking mentioned in Note XXVII;

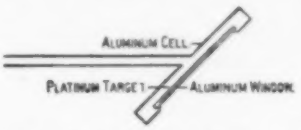



FIG. 32.—"ROENTGEN-LIGHT NOTES."

and if the cathode is placed in a tube at the end of the bulb and near the walls (as in ordinary commercial tubes before I pointed out the defects of this position) the glass is soon broken. To overcome these difficulties the cathode should be placed as shown in Note XXX, Fig. 30, Note XX, Fig. 5, and instead of being less than an inch in diameter, which is common, it should be two inches or more. These large cathodes are not necessary with small generators. In conclusion, I wish to make two things prominent: the cathode acts as a condenser—the size of the cathode should be in proportion to the size of the surges.

NO. XXXIII—PERFORATED CATHODES.

At a certain stage of the vacuum only the edges of the cathode appear active. At a higher vacuum only the center of the cathode seems to be the source. These appearances have led observers and tube-makers to consider a small cathode as good as a large one. In previous notes I have tried to prove the fallacy of this, and I now print a cut of one of the perforated cathodes I have used in my experiments. A glance at Fig. 31 will show that it has a solid center as large as the average cathode, and a wide, solid rim. If only the edges or center of a cathode were active, this one should be as efficient as though it was solid, but it is not. The cathode stream from it is so broken up and so little delivered at the proper point on the target that this is not made red hot by a current which would melt it with a solid cathode of the same size. The appearances of perforated cathodes of different designs are very beautiful, as are the figures they form on the glass walls, and both are worth careful study.

NO. XXXIV—ON THE FALLACY OF USING THE EQUIVALENT AIR SPARK AS A MEASURE OF THE DEGREE OF VACUUM IN A ROENTGEN LIGHT TUBE.

In the writings of men interested in vacuum tubes it is not unusual to find the degree of vacuum in a Roentgen light tube measured by the equivalent spark in air. That other data should

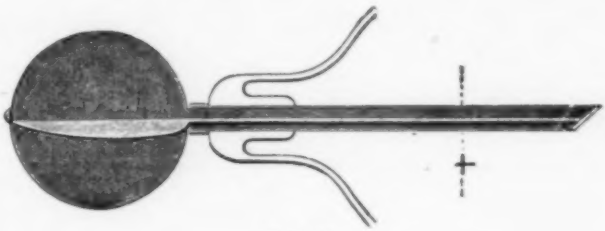
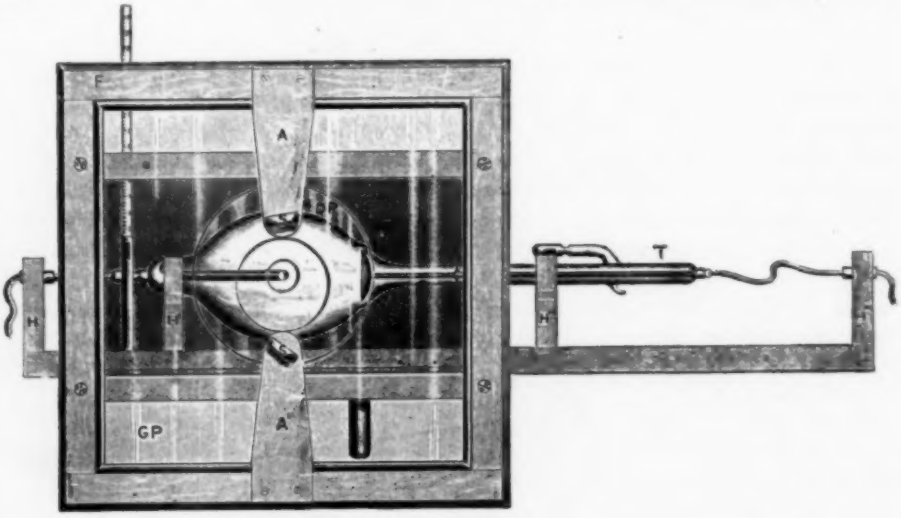


FIG. 33.

accompany this statement is shown by the following experiments. If we keep the temperature of the water at 30 degrees centigrade, in a tube like that shown in Figure 30, Note XXX, and pump the vacuum until the resistance is equal to nine inches of air, when the tube is excited on a large static machine, we shall find on exciting it with a Lawrence and Norton coil and a 20-microfarad condenser, that the equivalent spark in air is much less, usually about three inches. If we now excite the tube on an alternating-currrent dynamo, the length of the

equivalent spark in air will be still less. Even with different types of induction coils, the equivalent air spark varies, depending on the mode of winding. As extended description of experiments is out of place in these short notes, I say briefly that at the degree of exhaustion required to produce Roentgen light, the resistance of the tube, as measured by the equivalent spark in air, is inversely as the voltage; that the lower the voltage, the higher the vacuum must be to produce an equal amount of Roentgen light.

the deposit does somewhat diminish the efficiency of the tube I tried covering the target with a thin layer of aluminum. Such a target is shown in Fig. 32. Fig. 33 shows the same idea applied to a cooled target. I hoped that the platinum would act like the silver coating at the back of a glass mirror and prevent the loss by transmission which was supposed to take place when aluminum was used as a target. I first tried this experiment two years ago and do not now attribute much practical importance to this form of target, believing that the efficiency of




SCALE, ONE SIXTH.

FIG. 34.

NOTE XXXV—COVERING THE TARGET WITH ALUMINUM.

If we examine a Roentgen-light tube having an aluminum cathode and a platinum anode we shall find, after it has been used a considerable time, that the deposit on the walls is of two colors. There is a more generally diffused purple deposit from the cathode and a less generally diffused brown deposit from the platinum. Fortunately, the latter deposit is less in front of the target, otherwise the amount of Roentgen light yielded by the tube would be more rapidly reduced than it is by use. As aluminum is not so much due to its transparency to Roentgen light as to the fact which this experiment pointed out—that the individual particles of the cathode discharge are not raised to so high a temperature by the same voltage when they strike an aluminum target as when they strike one of platinum or some allied metal, because the shock of impact being less sudden, heat is developed during a longer time and therefore never attains the maximum.

NOTE XXXVI—DIAPHRAGMS FOR ROENTGEN LIGHT TUBES.

So many experimenters, the writer

among the number,* have invented the diaphragm for sharpening the shadows cast by objects in the path of Roentgen light that it is a matter of some difficulty to determine to whom the credit belongs. Very probably it belongs to Roentgen, as almost everything appears to do except Trowbridge's discovery that under a sufficiently high voltage every

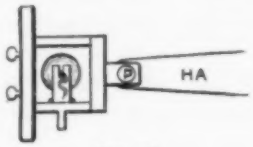



FIG. 35.

part of a continuous metallic conductor gives off Roentgen light. However, the first mention I have found is an article by Leeds and Stokes in the *Western Electrician* for March 14, 1896. Considering the value of diaphragms it is remarkable that within a little over two years of their discovery they should have practically gone out of use. As we increase the power of our generators it becomes more important to employ them because, as stated in Note XVII, a powerfully excited tube gives Roentgen light over a large surface beside the radiant area on the target.

Diaphragms have always been made

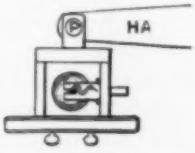



FIG. 36.

of metal, but this is objectionable, because a conductor placed between the terminals of a tube reduces the length of the air-column and consequently the available spark length, besides increasing the danger of puncturing the tube. To overcome these difficulties I use glass half an inch thick. The arrangement is shown in Fig. 34. It is a wood box to hold the tube, and a frame for the glass plate G P, which is one foot square with a three-inch hole in the center. Covering the hole is another circular glass plate D P, with a smaller hole in the center The latter plate can be removed and one with a different size hole substituted. The plates are held in contact by the screws S S on the ends of the two arms A A. As stated in my first article on this subject, this is simply the principle of Zentmayer's microscope stage applied to another purpose. It enables the experimenter to easily bring the opening in the diaphragm in proper relation to the radiant area on the target. The use of glass instead of metal occurred to me from seeing Dr. Williams' glass screen, which he keeps between the tube and his legs when examining patients. Figs.

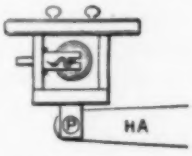



FIG. 37.

34 and 35 show the tube-holder in position for examining a patient in a vertical position, Figs. 36 and 37 its positions above or below the patient when he is lying down. The whole holder has a vertical range of six feet by means of the arm H A partly shown.

NOTE XXXVII—COOLING THE TARGET WITH METAL VANES.

Instead of using water to cool the target when we use moderate amperage, it is sufficient to put a copper stem into the hollow platinum target and expand the end into four vanes, as shown in perspective and section in Fig. 37.—*Electrical Review*, N. Y.

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X-RAYS.—The Duke of Newcastle is presenting a complete and valuable x-ray outfit to the North-Eastern Hospital for Children at Hackney.—*The Electrical Review*, London.

*International Dental Journal, August, 1895.

# LONDON ITEMS.

J. W. BARBOUR, M. D.,
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## ROENTGEN RAY PRINTING.

M. Georges Izambard, of Paris, who describes himself as a literary man, has devised the following system of utilizing the x-rays as the foundation of a method for superceding typographic printing. We give M. Izambard's description in full, and as nearly as possible in his own words.

THE X BLOCK PRINTING BY MEANS OF THE X-RAYS.

I. PURPOSE OF THE INVENTION.

It is a new process for the simultaneous and instantaneous printing on both sides by means of the x-rays, of numerous sheets (of sensitized paper) superposed in quires or blocks (newspapers, trade papers, &c., whatever their size may be). It purposes to obtain new results analogous to those obtained as yet through typographic printing and other processes derived therefrom. It tends to suppress: firstly, composition; secondly, striking off by the printing machine.

1. It can suppress composition, it allows mere handwriting or any kind of writing machine to supply the place of the long, complicated, and tiresome work of associating and disassociating printing types (composition and distribution). This will cause an economy of time and workmanship, inasmuch as a small number of workmen will be able to do more work in a few minutes than a large number in several hours.

2. It can suppress striking off by the printing machine. The operation of striking off, in spite of the progress realized and the marvelous improvements press machinery has received, remains, nevertheless, very slow work, the sheets having to be printed one by one. Nobody had yet come across the idea that a means might exist of printing them all at the same time. This means it is that starting from the known property of the x-rays I have endeavored to find. I cause these rays to act at one time on a block of sensitized paper, or even on several blocks placed circularly around the radiant center, thence a new saving of time which the plainness of the working stock employed easily accounts for.

II. WHAT MEANS DOES THE PROCESS EMPLOY? THE RAY-PROOF INK, THE RAY-PROOF DUST, THE TYPE SCREEN.

The means, thanks to which the x-rays may be employed, I consider as the very substance of my invention; it consists in a ray-proof substance, be it an ink or a powder, with which characters are to be traced upon a screen. This screen I call "the type screen." It consists of a sheet of paper, pasteboard, thin wood, leather, or tissue drawn over a framework. We place the screen between the radiant center and the block of sheets we wish to act upon at one time. The characters alone, stopping the x-rays on their way, will prevent their acting on the sensitive emulsion spread over every sheet of the block, whereas the remainder of the screen being of paper or wood will let the rays through easily as a plate of glass would any ordinary light. The type screen here plays about the part of what is called in photography a "phototype." In fact, the type screen will let the x-rays through just as the plate or film of a phototype exposed in a framework will admit the white light or the daylight.

III. THE VARIOUS OPERATIONS.—ALL THE SHEETS FORMING A BLOCK IMPRESSED AT THE SAME TIME.—THE RAY-PROOF INK, THE TYPE SCREEN.—PRINTING AND HANDWRITING REPRODUCED.

We take some photographic paper which an emulsion has sufficiently sensitized (a gelatine-bromide emulsion, for instance). This paper must be cut out into sheets of an equal size, which

we will then superpose (the gelatinized side turned upward) in order to form a more or less voluminous quire. This block having to be exposed to the x-rays must be wrapped in black paper, in order that the daylight may not affect it. Before operating, we place above the block, as we would a screen, a sheet of paper, cardboard, or wood, bearing characters of a metallic substance. We can strike out of a sheet of metal the full or hollow characters we want and stick them on the screen in the desired order; but this would mean much time and patience. It will be better, in order to simplify our task, to compose a page of typography by means of ordinary printing types. We must ink this page and draw a proof of it on the paper or tissue of the type screen. Only, instead of smearing the inking roller with ordinary printing ink (of which the Roentgen rays would leave but insignificant traces on the sensitized paper), we must have recourse to a special sort of ink, much less pervious than this to x-rays, and which must therefore be composed in greater part of metallic or calcareous ingredients. Thus, just as during the exposure the white rays are intercepted by the shades of the phototype, so will the x-rays be during the radiographic process by the ray-proof ink (I shall not speak here of the composition of this ink, considering that I give later on all necessary information regarding it as well as the various manners of preparing it—as the possibility of substituting a likewise metallic or calcareous powder). We are equally free to fill up the page with handwriting, to use the pen or the brush in order to reproduce autographs, drawings, music, &c. We only have to dip our pen or pencil into the specially prepared ink, and, as before, the type screen, thus covered with ray-proof characters or lines, will give us after a few minutes', or even a few seconds', exposure to the x-rays, as many proofs as there are sheets in the exposed block. The number of proofs thus obtained (which must next be "developed" and "fixed") will be in proportion to the time of exposure, to the thickness of the layer of ink, as well as to the radiographic "opacity" of this ink, to the thickness of the sensitized paper, to the degree of sensitiveness of the emulsion, and, above all, to the combined strength of our elements and induction coil and tubes, especially to the length of the spark given by the Ruhmkorff coil.

*Optional Use of a Writing Machine.*—But why should we take the trouble to compose when any writing machine will do our work with an incomparably greater speed? We need only smear the machine's inking apparatus, be it a tympan or a roller, with ray-proof ink, to be able to draw in a few seconds an unlimited number of copies of the text which will have been directly printed upon the type screen. The idea we have had of using, instead of metal characters, a ray-proof ink, has alone rendered possible, and even easy, the assistance of a writing machine which until now would have been considered totally impracticable, because no other means of striking off was contemplated but the press, with which, indeed the use of a writing machine is incompatible.

*The Sheets Impressed on Both Sides.*—Until now we have only thought of impressing one side of the sheets contained in the block, the other not having been previously sensitized; and this with good reason, for, had it been otherwise, all we should have printed on the obverse, would have more or less appeared on the reverse, but inverted, as a drawing on transparent paper would appear were we to look at it on the wrong side. This, however, can be avoided. the sheets remaining, nevertheless, liable to be impressed on both sides, and even simultaneously; to obtain this result, the lines on the odd page, instead

of coinciding with those of the even one, must, on the contrary, alternate with them, the paper having been, of course, sensitized on both sides, not on its entire surface, but by parallel stripes, alternating from one side to the other, the lines of the obverse (sensitized) coinciding exactly with the space lines of the reverse (unsensitized underlines), and, *vice versa*. In consequence, we must adopt a constant space between the lines. This space may be as wide as the total height of the type, or wider, but in no case narrower, or the tops and the feet of the letters would get entangled, thus producing a sort of "fulling."

To prepare the type screen in order to print the sheets on both sides, we write page 2 directly on the back and between the lines of page 1, or else we write page 2 on a separate sheet, which we stick on the back of the other, being careful, however, not to let the lines coincide. Likewise, placing this double screen in front of the block we wish to impress, and which is still protected by its wrapper, we shall have to take all necessary measures in order that the lines on the screen should coincide exactly with the sensitized parts which are to be impressed.

*Final Operations: Automatic Developing, Fixing and Rinsing.*—I need not describe here the operations, which consist in developing and fixing; these will take place in the usual manner, with use of the best adapted chemicals, doses, and methods. We must grant, however, that the time and care required to develop, fix, and rinse, as these operations are practiced in photography in order to obtain fine proofs, may seem a hindrance in the present case. We must simplify the work, for the reproduction of a photographic page may be carried through with care and taste without requiring, nevertheless, the refinement that a work of art, landscape, or portrait, would. I will therefore point out, should speed be sought for, above all, the simplifying means that can be adopted in developing and fixing.

In a room lighted with a red light some large square vats will be prepared to receive the impressed blocks as soon as they have been rid of their protection wrappers. The bottom of these vats must be provided with taps to let the water run out, while a movable double bottom consisting of a metallic trellis will render the drainage easier. The developing and fixing liquids will, at the right moment and in the needed quantity, flow into these vats through a system of pipes laid on the sides, so as to supply a rotary current. Other pipes will, in the same way, bring us the water required as well for the intermediate as for the final rinsings. After the suitable immersion, and the water having run out, the blocks may be allowed to remain in the vats, where they will drain through the metallic trellis; or else they may be conveyed into a room heated to the purpose, or even exposed to draughts of hot air. Their drying may also be hastened by the immediate neighborhood of quantities of chloride of lime, which is known to absorb dampness very rapidly. We may let the gelatino-bromidized paper drying on over or in front of a clear fire, provided it has been steeped before the rinsing in a solution of ordinary formol at three per cent; the gelatine becomes thus insoluble.

No doubt that in some cases the very weight of the block may prevent the developing and fixing liquids from penetrating entirely between the superposed sheets. This inconvenience will be avoided if the sheets in the blocks are separated one from another by sheets of blotting-paper. The draught printing off by means of the x-rays, as the subsequent bathing will not take us longer for this, as the block can be prepared beforehand in the manner we mention. In this case, however, they will, of course,

contain half as much sensitized paper as before, their thickness remaining the same, and the number of drawn proofs will, in consequenee, be smaller by half.

*Printing in Black on a White Ground.*—The actually manufactured (gelatino-bromide) papers and other similar ones used to reproduce phototypes give, as is usually said, a positive from a negative, and *vice versa*, which means that the portion of their surface reached by the light blacken. If we make use of this sort of paper, our sheets will be printed in white characters on a black ground. Should we wish to obtain the opposite result, black characters on white ground, we must add to the developer some product known to "upset" the image. Such products are mentioned in all the most recent photographic treatises. We might reach the same end by furnishing the writing machine with hollow characters (*caracteres en creux*) instead of full ones (*caracteres en relief*). It would then be the little square surface surrounding the letter that the ray-proof ink would cover and transfer upon the screen, the result being a black impression on a white ground, obtained on both sides of the paper as easily as on only one alone.

It is to be remarked that (to produce a negative on a type screen, and consequently a positive on the sheets composing the block (we can take advantage of the well-known properties of bichromated compounds (gum, gelatine, or albumen), and obtain thus, with the help of photo-collography and without loss of time, the photo-typographic *cliche* we require, for, the radiographic ink we use being like printing ink, a fatty substance, will adhere as the former would to the bichromated parts of the sheet which will have been previously exposed to the sun. (See here below.)

*The "Radiographic" or "x-ray-proof" Ink.*—The composition of this ink will vary according to the use we wish to make of it, but in all cases it may be composed in greater part of a very divided or calcareous powder, in order that it may form with the other ingredients a close mixture. To produce this powder we can use bronze or copper, white zinc, or white lead. For handwriting white lead in a solution of gum will be very suitable. The powder may be mixed preferably with boiled linseed oil for the writing machine or ordinary typography. White lead well ground down, as it is manufactured for painting purposes, will be found preferable. The various compounds may also contain some alkaline bromide, like bromide of potassium, which opposes a pretty strong barrier to the x-rays. I form there a weighty claim regarding the appropriation of this ink to constitute what I call the type screen. There are two kinds of radiographic ink; one is fatty, the other non-fatty. Besides, we may add, with either in several cases, a bichromatic mucilage. But we need not do it always; not even with employ of the photo-collography, as in the following instance:

Let us prepare, instead of ordinary ink, a bichromatic mucilage (that has not been previously exposed to the action of light wherewith we write by means of a pen, or wherewith we print by means of a type-writing machine. We roll thereupon and ink-roller that is coated with fatty radiographic ink; therefore the letters, having not taken the fatty radiographic coat (by virtue of their preventive mucilage), remain alone permeable to the x-rays, whilst all the page is elsewhere impermeable. Here is the requisite negative type screen for the printing in black on a white ground.

*Another Way of Proceeding; the Impervious Powder Employed Separately.*—One need not necessarily use a ready-prepared ink or paste; but wet the pen, the brush, the tympan, or pad, or ball, or roller, or ribon of a type-writing machine with any unmetalized substance, provided it be

sufficiently gummy or sticky and do not dry too quickly, say, as a solution of gum, a varnish, or ordinary printing ink. We then print the type screen, over which we next sprinkle the pulverized metal as we might to powder ordinary ink in order it should dry quicker. The powder, adhering, of course, only to the inked surfaces, these become at once quite opaque. Should a little powder remain on the uninked surfaces, we remove it with bellows or by any other means of ventilation.

*Printing on Large-sized Sheets.*—If it is possible to impress simultaneously several blocks by means of a single tube, in some cases, on the contrary, we shall want several tubes to impress one block, and that will be when the size of our paper will be very large, offering a very extensive surface. Indeed the x-ray emanating from a central point, and, as is well known, spreading in a straight line only, without reflection or refraction, would strike perpendicularly the nearest parts, *viz.*, the center of the sheet, and obliquely its furthest extremities. The perpendicular rays would impress the paper as desired, while the oblique ones, working their way in a straight line, would remove the reproduced image more and more from the center as they penetrated further in the block, the last sheets of which would be covered with distorted lines and fringed letters, having perhaps so far lost their shape as to be unreadable. In short, these distortions would recall the spherical aberrations produced in optics by certain defective lenses. This defect might, in a certain measure, be remedied by curving the block provided with its type screen so far as to place all the points of its median line at an equal length of radius, in order that it should form a portion of a circumference, having the radiographic tube as its center. This, however, only shifting the difficulty, for theoretically we should have to give the block not a semicircular, but a hemispherical curvature. Fortunately, we can do better. If we have, for instance, a large sized newspaper to print, we can set several induction tubes to do the work simultaneously, increasing, of course, at the same time their respective batteries. We must be careful, however, to separate the tubes from each other by sufficiently thick metallic partitions, in order that the rays, issuing from different sources, should not by crossing each other impede their respective effects.

*Correcting the Proofs*—The proofs obtained with the type-writing machine will be almost faultless, provided we be sufficiently attentive. This is not the case with manual composition, where mistakes are often made in distributing, letters often placed upside down in the composing stick, &c. Nothing takes more time and is more wearisome than the overrunning required to correct typographical proofs, not to speak of the delays that may be consequent on a slip of a letter-packet, of a column or an entire page "falling into pi" at the last moment. With the new process nothing of the kind is to be feared. We scratch out on the screen the defective words and use the writing machine to write them over again, an operation which will leave no trace upon the proofs. Is an intercalation necessary? We use a second sheet of paper, upon which we write the lines and paragraphs required to complete the text, even as the additional readings proceeding from the authors. The passages which are to be suppressed or lengthened having been previously cut out of the text with a pair of scissors, we take advantage of the making up and stick the corrected passages in the spaces left vacant for them. This will not require, as might be thought, a minute cutting out; for, provided the additions be adjusted to the text of the proof, a little more paper necessary for them to coincide exactly with

the empty spaces may jut out without inconvenience, whereas all paper untouched by the ray-proof ink, remains absolutely permeable to the x-rays.

*Making-up and Paging.*—The properly called making-up is easy enough ; it consists in sticking in a given order and dividing into columns and pages the proofs drawn with the machine according to the "measure" adopted ; next, when superposing the twin pages which form the double screen, in alternating the obverse and reverse lines, as I explained before.

*A Curious Cryptographical Appliance.*—Governments and their agents might employ our process to print, under sealed envelopes, State papers, diplomatic documents, confidential circulars, in fact all so-called "secret" documents, which could not until this day be kept strictly secret, considering they had to be composed and struck by third persons. This is how to operate: The high functionary in his office need only use our ray-proof ink to write out with an appropriate writing machine his original text. He next encloses it (unfolded, of course) in a large-sized envelope or bag bearing his seal on one of its corners. It is then sent with his orders to the establishment appointed for official publications. There are kept already sensitized blocks of a known size and capacity, wrapped and sealed in an untearable wrapper. Before these we need only now place the envelope, sealed as it has remained, and expose the whole to the action of the x-rays, in order to obtain the desired number of copies. The operation being thus centralized, all scattering avoided, and no third persons interfering, takes place rapidly enough to be superintended, from beginning to end, by the manager of the establishment, who is aware of his responsibility. Immediately afterwards, the envelope and their blocks, their seals yet unbroken, are returned to him who gave the order, and who may either do himself the developing and fixing automatic work, or let it be done before him in a dark room attached to his office ; or, better still, enclose each paper in a thick envelope and leave the care of developing to the person to whom the circular communication is sent, what will certainly cost to them a less time than to read a cipher.

*Recapitulation,*—Any sort of writing machine the inking roller of which is provided with a ray-proof ink, may serve to write on a single sheet ray-proof letters. This single sheet is placed as a screen between the x-rays and a block of sensitized paper. Thereof results a simultaneous and instantaneous print-impression on numerous sheets ; there remains to develop and to fix. Such is, in substance, my "block-printing process."

This elementary combination suffers different readings, viz. :—

I. If we use an ordinary writing machine, the characters of which are in *relievo*, a white text appears on a black ground, as would a negative proof ; but, if we furnish the writing machine with characters in hollow, viz., if we reserve on the tip of the keys a little metallic cube, wherein the letters are scooped, indeed the type screen is figured by a continued series of lines, and the lines by a series of little opaque squares ; each square in its middle contains a clear letter permeable to the x-rays. It is really a negative, the final result, after the radiographic operation, will be positive pages, viz., a black text on a white ground.

II. If we use, to prepare the type screen, an unmetalized ordinary ink, provided it be sufficiently gluish, it will suffice to sprinkle pulverized metal over the screen sheet. The inked places will become thereby quite impervious to the x-rays.

III. If we use, to write on the type screen, the bichromatized mucilage not being previously insolated; and thereup-

on set in motion an inking roller coated with "fatty" radiographic ink, this fatty coating will adhere to the unwritten surface of the page, which becomes opaque, while the letters, not receiving this ink, remain permeable to the x-rays. The text, as before, appears black on a white ground.

III. *bis.* Here, again, the metalline powder can be separately sprinkled on the screen, and adhere to the unwritten surface, the letters excepted, which will remain permeable and appear black.

IV. If we use for the blocks a paper partially sensitized on both sides, viz., by parallel allotments, alternated in order that the sensitized lines of the right page coincide exactly with the non-sensitized interlines of the back page, our blocks are thereby enabled to be impressed on both sides.

V. We are at liberty not to use one radiant center alone, but may place suitably several induction tubes in front of the same block, separating the tubes from each other by metallic partitions. We shall thus print large-sized blocks, and avoid spherical aberration.

VI. We may, by virtue of our method, put in execution such-and-such an appendant operation as, for example, the copying of sealed documents on sealed blocks. There is the method with its different readings. Hereafter are the results.

The method gives us in general :—

Not merely, as with current radiography, some negative phototypes on glass, or film, requiring a subsequent drawing or insolating, .... but even immediate positives on paper, without subsequent drawing or insolating, these copies being similar to those obtained by the printer's work, and as readable, as numerous, but rid of typographic composition and press machinery; and therefore more rapidly produced.

The method gives us in particular :—

Not merely, as with current radiography, (*a*) drawn silhouettes of opaque bodies or autographical writings (*b*) in white strokes on a black ground (*c*) on one side alone (*d*) on small-sized sheets, . . . . but also (*a*) characters printed with the writing machine (*b*) in black on a white ground (*c*) on both sides (*d*) on large sixed sheets, as used for newspapers, and so forth.

The method is therefore a combination of various means, some of which are already known, others either entirely new or renewed by partial improvements, but aim all, however, at an entirely new result, "the simultaneous and instantaneous printing of numerous sheets."

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Rays and Vegetable Life.—A good deal has been written upon the Roentgen rays, perhaps *ad nauseum*, but experiments on their action upon vegetable life have, up to the present, produced no satisfactory result. Signor G. Tolomei, writing to the *Atti Dei Lincei*, is led to the conclusion that their action is identical with that of light. On exposing branches of *Elodea canadiensis*, immersed in water charged with carbon anhydride, to the action of the rays, evolution of bubbles took place, as in the presence of sunshine, electric or magnesium light. The same similarity was observed in the effects on the lower vegetable forms, both Roentgen rays and light causing retardation in the absorption of oxygen by *Mycoderma aceti*. Again, in their action on *Bacillus anthracis* the Roentgen rays behave in the same way as sunshine, but in a minor degree. When a photographic gelatine film was exposed for twenty-four hours to the radiations from a Crookes' tube with the interposition of a zinc screen having an X-shaped aperture, the letter appeared transparent on an opaque background. That the action was due to the destruction of the germs, and not to the generation of any toxic quality in the agar, was proved thus: When a sterilised

film was partially exposed to the rays, and subsequently brought into contact with a stratum of dried spores, the spores began to germinate all over the film, but when the stratum of spores was exposed to the rays, the screen with the letter X being interposed, and the photographic film subsequently brought into contact with them, only those spores which had been protected from the Roentgen rays developed, and the letter X was distinctly seen. Signor Tolomei attributes the previous failure to obtain such effects to the short duration of the exposures.

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X-RAYS. [41319.]—A few days ago I wished to see if the x-rays would pass through an ordinary glow electric lamp. I was working with a 6 in. coil and 12 volts; the tube was a "Penetrator," made by Watson. It was inclosed in a wooden box, the cover being made of thin wood. The current was taken from the coil to the tube by ordinary covered telephone wire. The wires passed through thick glass tubes about 6 in. long; these were inclosed in second glass tubes, kept steady by india rubber.

Directly I placed the glow-lamp on the box, it became luminous. I found if the lamp was placed on its side, and the brass collar or the glass itself touched with a finger, it glowed brightly, or *vice versa*, if the brass collar was placed on the box, and the glass touched, the same light appeared, similar somewhat to the light produced in an exhausted flask by frictional electricity. I next put a piece of thick plate-glass on the box, and stood the lamp on it. Still the light appeared. I then placed a piece of sheet-lead on the box, and stood the lamp on it. This plan increased the light. Sometimes a small spark could be seen passing between the lead and the lamp. If the lead was touched with the finger while the lamp was on it, the light immediately ceased.

The lamp was held against various parts of the box—not only touching it, but some inches off, and also on the table fully 3 ft. away from the tube and coil. The same glow appeared brighter, or less bright acccording to the distance from the box. The light differed in brightness when the lamp was placed in various positions. There were especially two bright spots; but, strange to say, there was a diagonal line across the top of the box, along which the lamp remained almost completely dark, and in one place absolutely no rays were given off at all, and the lamp remained dark.

I then tried about a dozen other glow-lamps. Most gave no trace of light, a few glowed slightly. Decidedly the best were a 25-volt obscured lamp, a 10-volt lamp, two Maxim 50-volt lamps.

I then used three x-ray tubes instead of the glow-lamp. Two of them gave occasional flashes of light, but quite different to the light given by the lamp. The one that produced a slight glow similar to that given by the glow-lamp was a tube made in the very earliest days of x-ray work. I think it was an ordinary Crooke's tube. It is known among my friends as the "fat pig" tube, from its shape.

These experiments prove—First, that the tube inside the box is giving off rays in all directions which travel directly through wood, glass, lead, and other substances, or else cause these substances to give them off, but that to a great extent they are arrested by the wood itself, as is shown by the lamp glowing better when it touches the wood.

Secondly, that in all probability the glow only takes place if the degree of rarefaction is suitable.

So far, I do not think this glow is caused by the x-rays, for the lamp glowed behind the anode, where, according to the screen, no rays are given off, but I believe it is not unlikely that a suitable vacuum may be produced, the air of

which will be caused to glow only by the x-rays.

I next took the tube away from the inside of the box, and simply let the coil spark across the gap, but no rays were given off. I then separated the wires beyond sparking distance, but still no light. Afterwards I replaced the tube, and stood the box on a thick glass plate, to insulate it. This made no difference. Next I stood on a glass stool, so as to insulate myself, and then touched the glow-lamp. I found the insulation made no difference. I then tried the coil alone, and placed the terminals beyond sparking distance. I found that the lamp, when placed a few inches from the coil, glowed to a certain extent, but not brightly, and no rays were given off by the table and surrounding objects. I also found that, just as with the box, there were certain positions in which the lamp remained absolutely dark. I tried two other tubes instead of the Penetrator (both of earlier type). In one case there was no trace of light; in the other a very faint glimmer.

The above experiments seem to me to prove that there is a vast amount of electric energy going on all around a highly exhausted tube, and this electricity may be the cause of the sensation often felt by persons being x-rayed, if they are not caused by the x-rays themselves, and may account for the bad effects *said* to be caused by continued exposure to x-rays.

Since writing the foregoing I have placed ordinary vacuum tubes on the box, and find that they glow quite brightly. Two containing respectively hydrogen and argon show easily the distinguishing colors of these gases.

A. E. MURRAY.

From *The English Mechanic*, of 29th July, 1898.

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M. BECQUEREL'S DARK LIGHT.—We have on many occasions brought before our readers accounts of M. Becquerel's investigations into the radiations of what he terms dark light, which possesses properties very similar to the Roentgen rays, capable of the penetration of thick pieces of wood and other opaque bodies. He found, it will be remembered, that these radiations were inherent to the metal uranium and its salts in a very remarkable extent, and further investigations in the same field by M. and Madame Curie have led to the remarkable result of the probable discovery of a new element. These investigators had already discovered that certain minerals contain uranium and thorium (pitchblende, &c.) emitted the Becquerel rays to a marked extent. A large number of experiments were made in the endeavor to separate the particular constituent of the minerals alluded to that were active in the emission of the rays, and eventually a body was extracted which was more active than uranium to the remarkable extent of 400 times. The experimenters searched among all known elements for one that had an action at all comparable with this, but had no success, and they therefore state their belief that they have discovered a new element, and they propose to term it polonium (from the birthplace of one of them). The only objection to this theoretical body is that the active substance extracted does not give any spectral line except such as are due to impurities.—*British Journal of Photography.*

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Nevern Road, Earls Court,
London, Eng.

ROENTGEN LIGHT NOTES. Rollins. *Elec. Rev.*, August 17.—In this continuation of his long serial he shows the fallacy of using the equivalent air spark as a measure of the degree of vacuum in a Roentgen tube; other data should accompany this statement; for instance, the striking distance will be different whether a static machine or induction coil is used, also with different types of induction coils; at the exhaustion required the resistance of the tube as measured by the equivalent spark in air is inversely proportional to the voltage; the lower the voltage the higher the vacuum must be to produce an equal radiation. He shows that covering the target with aluminum gives no better results than platinum. The diaphragm for sharpening the shadows cast he now makes of glass half an inch thick instead of metal, as usual. Instead of using the water to cool the target it is sufficient for moderate currents to use a copper stem attached to the target to carry off the heat.

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ROENTGEN RAY.—Drs. Boas and Dorn report that they found that if an ordinary gelatine capsule filled with metallic bismuth is swallowed, its course through the alimentary canal may be outlined by the Roentgen ray. In cases of obstruction of the pylorus, or some portions of the intestines, this capsule is found arrested at the certain locality for days. They have made this observation by testing this procedure on fourteen patients with gastric affections, and recommend it as an excellent means of diagnosis.

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THE advantages of a routine use of the x-ray as a necessary part of an office equipment, should appeal to every surgeon. So numerous are the occasions for the use of the apparatus that today we would feel at a loss without it. No surgeon can dispense with this diagnostic aid, and the same necessity in the near future will appeal to the physician. —Dr. A. V. L. Brokaw, in the "Annals of Gynecology and Pediatry."

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### Transparency of Various Substances For Roentgen Rays.

Battelli and Garbasso have compiled the following table for the relative transparency of equal thicknesses of various substances, taking that of water as unity. Isenthal and Ward have added in their Practical Radiography, for better comparison the specific qualities:

| Material. | Specific Gravity. | Transparency. |
|---|---|---|
| Pine Wood | 0.56 | 2.21 |
| Walnut | 0.66 | 1.50 |
| Paraffin | 0.874 | 1.12 |
| Rubber | 0.93 | 1.10 |
| Wax | 0.97 | 1.10 |
| Stearine | 0.97 | 0.94 |
| Cardboard | .... | 0.80 |
| Ebonite | 1.14 | 0.80 |
| Woodcloth | .... | 0.76 |
| Celluloid | .... | 0.76 |
| Whalebone | .... | 0.74 |
| Silk | .... | 0.74 |
| Cotton | .... | 0.70 |
| Charcoal | .... | 0.63 |
| Starch | .... | 0.63 |
| Sugar | 1.61 | 0.60 |
| Bones | 1.9 | 0.56 |
| Magnesium | 1.74 | 0.50 |
| Coke | .... | 0.48 |
| Glue | .... | 0.48 |
| Sulphur | 1.98 | 0.47 |
| Lead ointment | .... | 0.40 |
| Aluminum | 2.67 | 0.38 |
| Talcum | 2.6 | 0.35 |
| Glass | 2.6 | 0.34 |
| Chalk | 2.7 | 0.33 |
| Antimony | 6.7 | 0.126 |
| Tin | 7.28 | 0.118 |
| Zinc | 7.20 | 0.116 |
| Iron | 7.87 | 0.101 |
| Nickel | 8.67 | 0.095 |
| Brass | 8.70 | 0.093 |
| Cadmium | 8.69 | 0.090 |
| Copper | 8.96 | 0.084 |
| Bismuth | 9.82 | 0.075 |
| Silver | 10.5 | 0.070 |
| Lead | 11.38 | 0.055 |
| Palladium | 11.3 | 0.053 |
| Mercury | 13.59 | 0.044 |
| Gold | 19.36 | 0.030 |
| Platinum | 22.07 | 0.020 |
| Ether | 0.713 | 1.37 |
| Petroleum | 0.836 | 1.28 |
| Alcohol | 0.793 | 1.22 |
| Amylalcohol | .... | 1.20 |
| Olive oil | 0.915 | 1.12 |
| Benzol | 0.868 | 1. |
| Water | 1. | 1. |
| Hydrochloric acid | 1.240 | 0.86 |
| Glycerine | 1.260 | 0.76 |
| Bisulphate of Carbon | 1.293 | 0.74 |
| Nitric Acid | 1.420 | 0.70 |
| Chloroform | 1.525 | 0.60 |
| Sulphuric Acid | 1.841 | 0.50 |

## TABLE SHOWING VIBRATION RATES OF PERIODIC PHENOMENA.

Reprint from a table by T. H. Musas in Electrical Revtew, April 25, 1896, and extended to the Roentgen Ray Octave

| Complete Vibrations per Second. | Octaves. | Observations. |
|---|---|---|
| 288,224,000,000,000,000.... | 58 | Roentgen Rays. (Volle's Rays.) |
| 144,112,000,000,000,000.... | 57 | ..... |
| 2,251,799,813,685,248.... | 51 | Ultra violet photographic limit, in vac. $3\times10^{15}$ per sec. (Schumann.) |
| 1,125,899,906,842,625.... | 50 | Photographic limit of solar spectrum, $1.053\times10^{15}$ per sec. (Coruu ) |
| 562,949,953,421,312.... | 49 | Green light near thillium line. |
| 281,474,976,710,656.... | 48 | Infra red, photographic limit. (Abney). |
| 70,368,744,177,664.... | 46 | Heat rays of solar spectrum, lowest direct measurement. (Langley.) |
| 17,592,186,044,416.... | 44 | Heat rays from substances below 100 deg. C. (Langley.) |
| .... | .. | Eleven octaves unobserved. |
| 8,589,934,592.... | 33 | Electric oscillation in small spheres. (Righi.) |
| 67,108,864.... | 26 | Electric oscillation in Hertz Resonator, 70 cm. diameter. |
| 8,388,608.... | 23 | Electric oscillations for flying bullets—photographs. (Boys.) |
| 262,133.... | 18 | Electric oscillations in Lyden Battery. (Fedderson.) |
| 32,768.... | 15 | Audible vibrations, extreme upper limit. |
| 16,384.... | 14 | Electric alternator and turbine. (Ewing.) |
| 8,192.... | 13 | Electric oscillations in Leyden battery. (Fedderson.) |
| 4,096.... | 12 | Music, highest note. |
| 512.... | 9 | Electric oscillations in Leyden jar. (Lodge.) |
| 32.... | 5 | Music, lowest note. |
| 16.... | 4 | Water surface waves of minimum velocity. |
| .... | 1 | ..... |
| .... | 0 | ..... |
| Seconds per complete vibration..... | .. | ..... |
| 2.... | 1 | Second-beating pendulum. |
| 32.... | 5 | Air pulsations in wind. (Langley.) |
| 65,536.... | 16 | Mean solar day, 86,400 seconds. |

THE much debated question whether the rays are able to stimulate the retina, or the optic nerve, or certain optical brain centers, has been revived by the description of a case in which the patient who was absolutely unable to perceive even the strongest light could make out the color of the fluorecscence and the shape of the x-ray tube. Another report concerns a man who, 12 years ago suddenly lost his sight, and who, by continued treatment with the x-rays recovered part of his sight.—*Practical Radiography*, page 139.

These points were probably gleaned from THE AMERICAN X-RAY JOURNAL, Vol. 1. No. 5. Although investigation had been made along this line by the editor of this journal, yet the only full and comprehensive report of the study and discoveries of the practical use of the x-ray for the blind were made by Dr. Francisco de P. Astudillo, of Habana, Cuba, and printed in full for the first time in the November, 1897, issue of THE AMERICAN X-RAY JOURNAL.

LONGEST HEAT RAYS. Rubens and Aschkinass. *Wied. Ann.*, No. 6; abstracted in the Lond. *Elec.*, August 12. *Electrical World*, N. Y.—They entered a step further imto the region where the spectrum joins the Hertzian wave system and attained a wave length of 0.067 mm, which is 100 times the wave length of red light and 60 or 70 times smaller than the smallest electromagnetic waves yet produced—namely, 4 mm; The gap between these, therefore, remains to be bridged. The property of these long heat rays is more closely akin to those of electromagnetic waves than to waves of light.

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THEORY OF THE ETHER. Larmor. *Proc. Roy. Soc.*, No. 398; abstracted briefly in the Lond. *Elec*, August 12. *Electrical World*, N. Y.—An article in the form of a supplement to his third memoir on the electrical theory of the ether, in which he deals with a priori difficulties encountered in the conception of orbital systems of electrons moving through a practically stagnant ether.

## PRACTICAL X-RAY NOTES.

BY JOHN DENNIS.

When the practical electrician is called upon to tune a discordant x-ray apparatus, there are many conditions confronting him which are not present in a lame motor, or indeed, in any other electrical contrivance which needs mending.

In the first place, it must be kept in mind that a vacuum tube, in perfect condition, is useless if the coil or static machine upon which it depends is out of order, and that the most perfect generator of current will not produce satisfactory x-ray effects from a tube in which the vacuum is too high or too low, or which has been "sparked."

The first necessary step, logically, is to ascertain the condition of the coil or glass machine, as the case may be. To do this in the case of a Rhumkorff coil, the first essential is to connect it up with the spark rods pretty close to each other at first, and with the vacuum tube out of circuit. If, when the rods are separated, the spark obtained is below the normal capacity of the coil, you may be sure that you have trouble, regardless of the condition of the tube, and that, for immediate purposes, that freaky instruments may be left out of the equation. You must, then, first devote your attention to putting the coil in proper condition, and, in a broad way, this is true in the case of a static instrument.

In looking for trouble in a coil, the electrician will naturally examine first the source of power, and at once try all of the connections. In cases in which the 110 or 220-volt current is used, with resistance, you must look carefully to all of the connections of the rheostat and controller, and it is well right here to connect in a low reading voltmeter and ampere meter. If the current delivered to the vibrator is normal the next step is to examine the brake wheel or vibrator, as the case may be; for if, in either case, these are bucking you will fail to interrupt your continuous current properly, and will, of course, obtain no action in the secondary. If all of these conditions are right and still you can not obtain a spark between the coils, there would be ground for a strong suspicion that the insulation of the coil had broken down. If, as before, the conditions described are normal and a spark much below the normal only is obtained, there will be a strong probability that something is wrong with the condenser. All recent coils for x-ray purposes have their condensers stepped in microfarads, and a persistent rearrangement of the plugs may remedy the difficulty, and it may not. In most of these recent coils, the condenser is more accessible than in the earlier machines, and they are easily reached by turning the case containing the coil on its side and removing the bottom screws. The condenser is easily removable, and taking it out will give an opportunity of examining as to the integrity of the connections inside the coil case. These connections are a bit complicated and can easily cause trouble. Care must be taken in removing and replacing the condenser, as its lips are necessarily tender. Of course the great cause of trouble in the condenser is puncture from overload. Whether you care to venture on the somewhat delicate work of dissecting the condenser of a high-grade coil and attempting its repair will depend upon your confidence in your skill as an electrician to replace that particular condenser by one of your own construction. The work is delicate, if not difficult, but there is no logical reason why you should not undertake it. At the same time, as I have intimated, I should not care to open up a condenser on a modern high-grade coil unless I felt qualified to construct one to replace it.

It is, of course, impossible to detect a puncture, or other defect, without actual

examination. Without this examination the condition of the condenser would be left to a process of reasoning based upon eliminating every other possible cause of trouble in the coil and its connection as a whole.

Personally, basing my conclusions upon experience, I should prefer sending the coil back to the factory, unless I was very certain that the trouble was in the condenser, and that I could readily find it by examination and remedy it myself.

If all connections are found to be right and a normal condition exists at the brake wheel and vibrator, and I could not determine that the condenser had gone wrong, I should be forced to the conclusion that the insulation of the coil had been impaired.

Right here I might mention a curious experience of my own. I had been operating a coil for several months with excellent results when the tube went out one night in the midst of a critical observation. From the action of the tube I knew that the trouble was in the coil or its connections. After trying for a time to discover the fault, I gave it up. The next morning I gave the coil a severe jar with my hand, and for an hour or more I had normal effects in my tube. My experience of the night before was repeated and the same thing occurred several times. My conclusion was that the fine secondary wire had become broken and that jarring the coil caused a temporary connection to be established. I shall never know, other than theoretically, whether this view was correct. The coil was sent back to the factory, and on its way it plunged into the Hudson river in a railway wreck and remained there several days. The condition of the coil was such that it was sent to the scrap heap and practically a new coil was substituted. But I shall believe that my conclusion was correct until I am convinced otherwise.

I shall not consume space by attempting to go fully into the causes of the failure of insulation of a Rhumkorff coil under the conditions existing in x-ray work. Sometimes it is gradual, in which case the trouble is owing to the melting of the paraffine in which the coil proper is embedded. Sometimes it is weakened in this way by prolonging its operation with the spark points near together. Sometimes it goes out suddenly under der an overload on the line, and oftener it gives out under circumstances which can not be readily ascertained without spending much time necessary for the investigation. In any case it is idle to spend any time in repairing a coil in which the insulation is broken down. Send it back to the factory where it was made, and the owner will have an object lesson in the vexations of x-ray work when the bill is sent in. You should not, however, form your conclusions too hastily and send a coil back unnecessarily.

It is to enable my friends among the practical workers to avoid this unpleasant and expensive experience of sending coils away, with the vexatious wait involved, that the writer is giving his experience and suggestions.

I am thoroughly seized of the opinion that much money and time can be saved to the x-ray operator, and many shekles transferred to the pockets of practical electricians, if an intelligent effort is made by them to doctor the outfit, and only send it home for repair when this is impossible.

If you have succeeded in your efforts to establish a normal spark between the terminals of the coil; if the spark is not only of normal length, but of the proper body, you will be ready to announce that the trouble is not in the coil or its connections, but must be looked for in the vacuum tube and its accessories; for the cathode glow in the tube is produced by connecting the terminals of the tube

in place of the air gap between the coil terminals.

It is, of course, essential that the delicate connections with the tube should be made carefully and properly and that the connections at the binding posts of the coil should be bright and good. Then results depend upon the conditions of the tube. Broadly speaking, these effects will depend upon the width to which the spark rods are separated, all other conditions of coil having been rectified, as I have tried to explain. When these have been properly established, the responsibility for x-ray effects remain with the tube; and it is difficult to find a more cranky instrument than a modern x-ray vacuum tube, and these peculiarities can only be properly considered at length in a separate paper. There are certain facts, however, which may be properly mentioned here.

If the vacuum in an x-ray tube is either too high or too low, results will be unsatisfactory. If the terminals in the tube are too close to each other, or, on the other hand, are too widely separated, the x-rays emanating from the tube (in some way yet to be clearly ascertained) will be of little penetration. If, when connected up, a pink glow shows between the terminals in the tube, it is punctured and useless for any other purpose than an interesting and expensive exhibition of pyrotechnics. In either of these cases the usefulness of the tube is at an end.

A somewhat extensive experience with x-ray vacuum tubes of types selected as the best, all things considered, has taught me that it is not good economy to send a tube back for repairs. The better way is to learn the best method of prolonging the useful life of a tube and knowing when its end has come. I consider it more economical, all things considered, to strip the tube of its platinum and throw the glass in the ash barrel. The life of a repaired tube is of few days and full of trouble, and it will certainly break down just at the time when it is most needed.

As I have said repeatedly, I consider it desirable that electrical workers should be thoroughly posted in the manipulation of x-ray apparatus, and I shall therefore take up the subject of the handling of tubes after I have considered the nature and repair of the glass machine, which in its evolution has now become an important, powerful and expensive bit of apparatus, which is not only utilized for x-ray work, but for many new and varied therapeutic purposes.—*Electrical Worker*, Rochester, N. Y.

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Dermatitis, &c., From X-rays.—Dr. N. A. Clive suggests that the power of electricity applied to the skin for driving remedies into the tissues (cataphoresis) has become one of the most useful means in neuralgias and other nervous disorders as well as for anasthesia in dentistry. But the x-rays does not destroy germ life as does electricity. It may be said to be entirely stripped of this power. But it does possess the power to penetrate all the tissues, rendering the hitherto darkened recesses of the human body as light as day. May it not carry with it the cataphoric effect to a certain extent, and drive into the skin the excretory products of that organ and other unclean things finding lodgment there, as well as disease germs themselves? Some experimentation along this line would not, at least, be amiss. We may not get the cataphoric effect to the extent of producing the taste of a remedy applied to the skin treated with the ray as with the direct current; but we may possibly get it to a sufficient degree to produce a dermatitis when the things capable of producing the trouble find lodgment on the skin. The writer is sufficiently possessed of this idea to be-

lieve that with properly enforced surgical cleanliness of the member to be treated with the x-ray, we would never cause the troublesome dermatitis so often complained of in its employment. And that at some time in the future it will be considered unscientific to apply the ray through an unclean skin, to say nothing of the clothes, dressing, &c., that may envelop the member.—*Health*, London.

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QUITE recently Dr. Hermann Rieder, of Munich, took up the experiments to prove or disprove the effect of x-rays upon bacteria, and arrived at the following results: Bacteria suspended in a jar, blood serum or gelatine, were destroyed after about an hour's continued exposure to Roentgen rays; cultures of cholera bacillus in bouillon require for their destruction a longer time (over two hours). Dr. Rieder believes that even if it should prove impossible to entirely destroy the bacteria in the human body, a partially destructive effect upon them by the Roentgen rays should greatly assist the organism in its natural protective struggle against the further development of the intruding microbes.—*Practical Radiography*, page 137.

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**Food and Teeth.**

George W. Williams, D. D. S., of Richmond, Indiana, one of the leading dentists of that State and a popular writer on dental subjects, in a recent article says:—"Many of the prepared foods sold for children are destitute of the qualities necessary to form sound and painless bones and teeth, and there is a great difference in growing up with fine grained, well glazed teeth in comparison with having the brittle, chalky teeth we commonly see. Diet is of the first importance in promoting the upbuilding of the bony system, and incidentally we would state that as a food for this purpose there is nothing that will equal 'Imperial Granum.' It is a pure, unsweetened food, made from the most nutritious portions of the finest growths of wheat. No derogatory word has ever been uttered by the medical or dental professions against Imperial Granum and its bone-building qualities. Perhaps the most important period in childhood is when the first set of teeth are erupting. It has been calculated that one child in ten has its life destroyed in consequence of diseases which have their origin at this time. Thus it is evident that children should be watchfully cared for, and I believe that besides those who die from diseases readily traced to irritation during the eruption of the first teeth, a number are the victims of diseases superinduced by general neglect of the mouth and the consequent tooth decay and improper mastication of food."

---

**Intestinal Antisepsis in Fevers.**

Though the typhoid, malarial and yellow fever epidemics in Cuba have not yet reached this country, it is well to guard against them by taking precautionary measures. If it be true, that the *materies morbii* of these diseases belong to the bacillus group, the remedies manifestly are an antiseptic and an antipyretic. As an intestinal antiseptic we have nothing better than salol. The consensus of opinion is in this direction. When we add the antipyretic and anodyne effects of antikamnia, we have a happy blending of two valuable remedies, and these can not be given in a better or more convenient form than is offered in "Antikamnia and Salol Tablets," each tablet containing 2½ grains antikamnia and 2½ grains salol. The average adult dose is two tablets. Always crush tablets before administering, as it assures more rapid assimilation. It is not our desire to go into the study of bacteriology here; our aim is simply to call attention to the necessity of intes-

tinal antisepsis in the treatment of this class of diseases. If in the treatment of these diseases, an intestinal antiseptic is indicated, would not the scientific treatment of the conditions preceding them be the administration of the same remedies? Fortifying the system against attacks is the best preventive of them.

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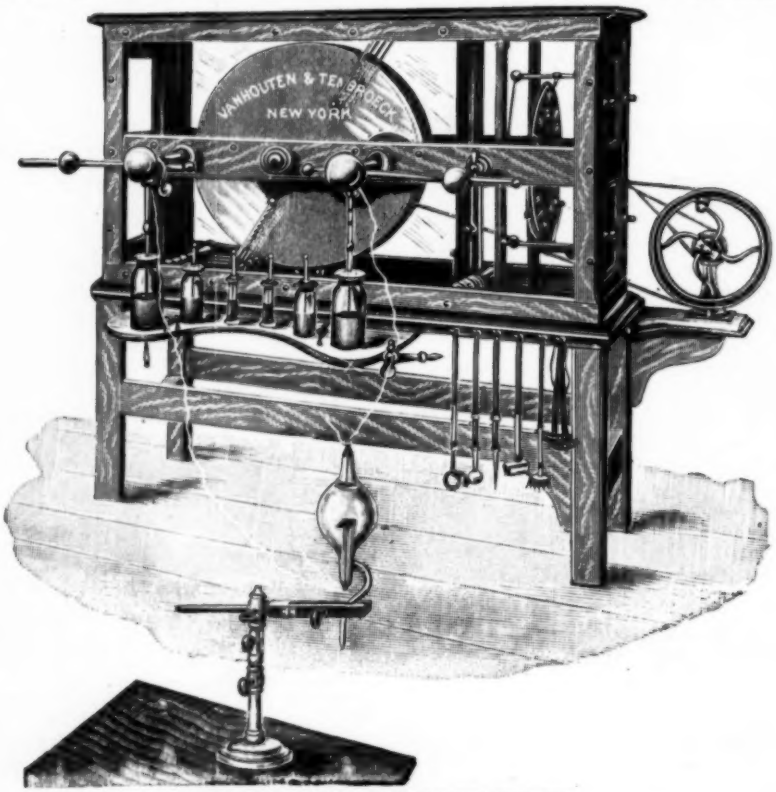


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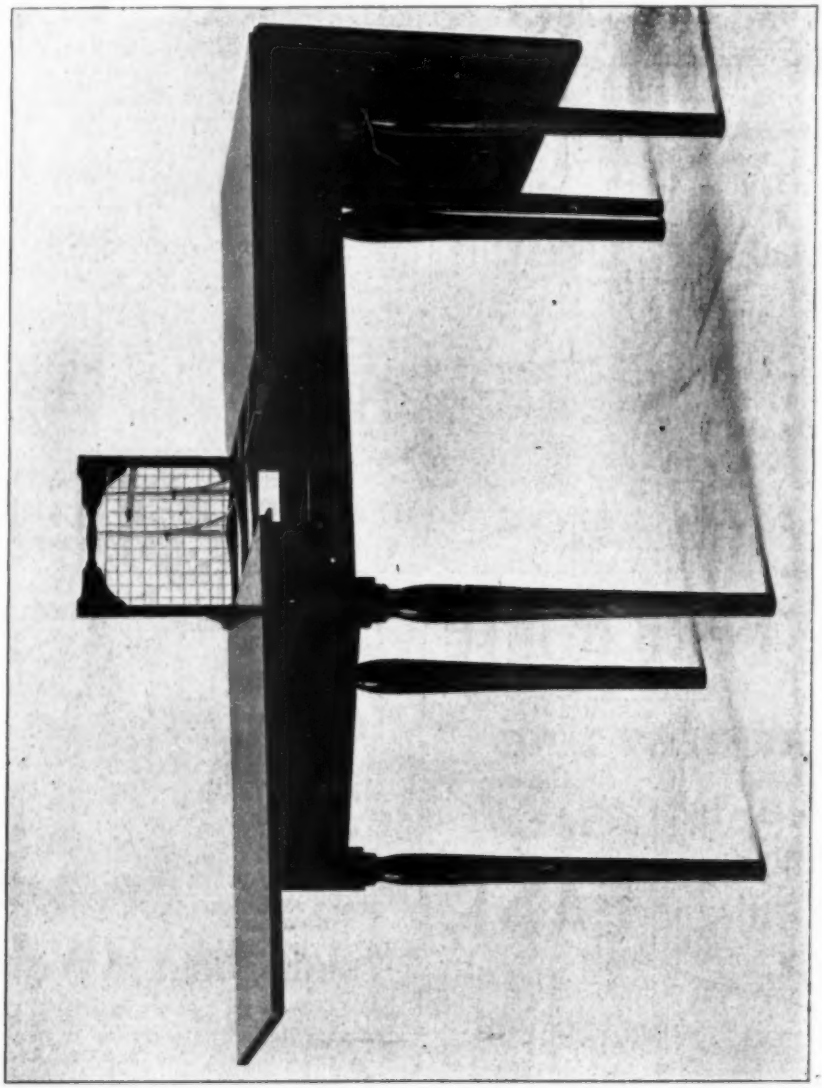

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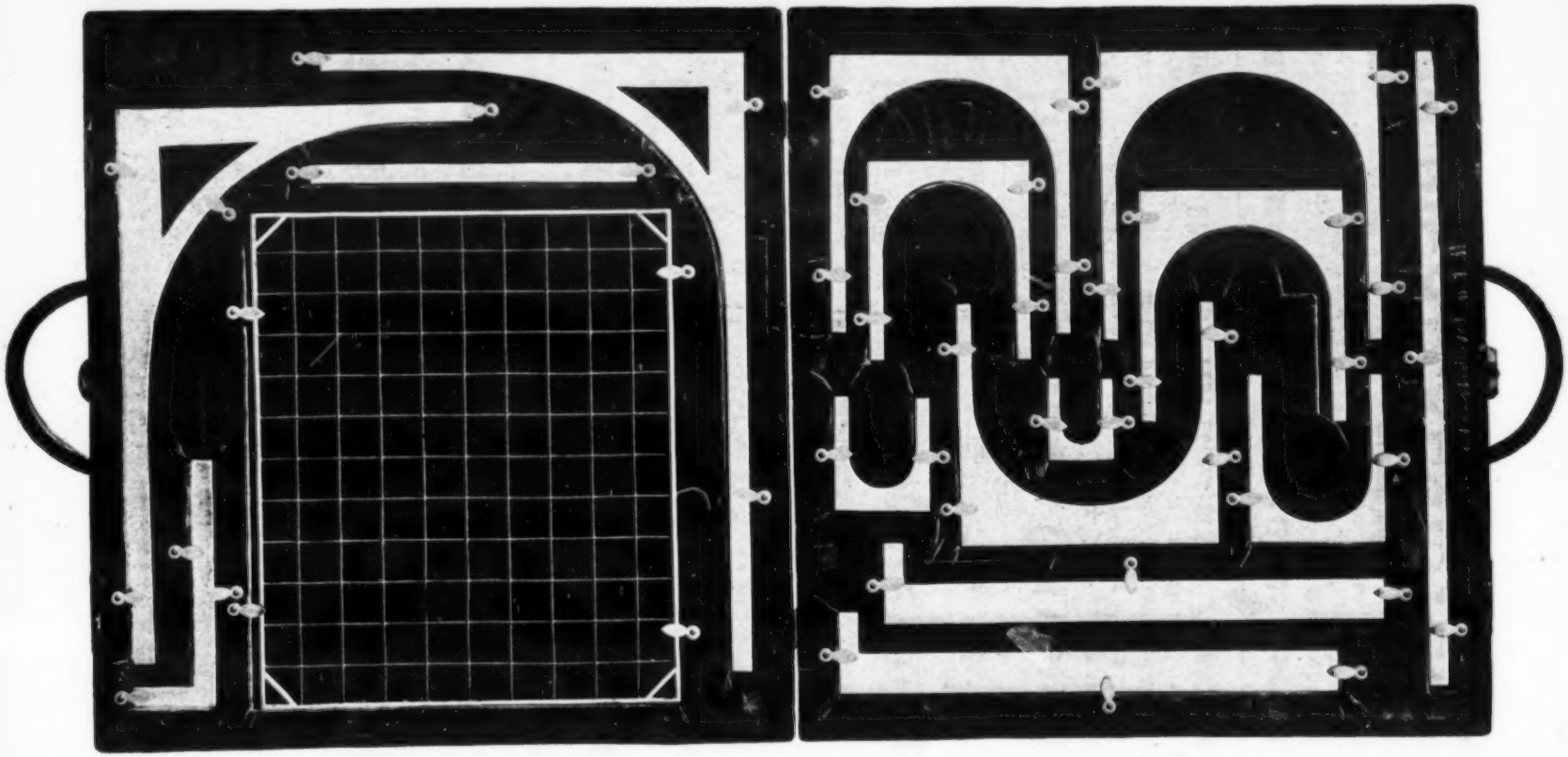

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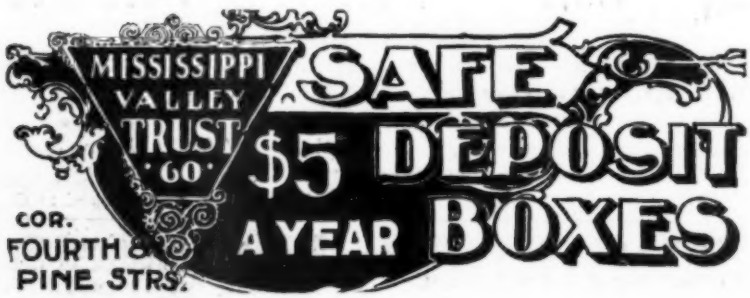


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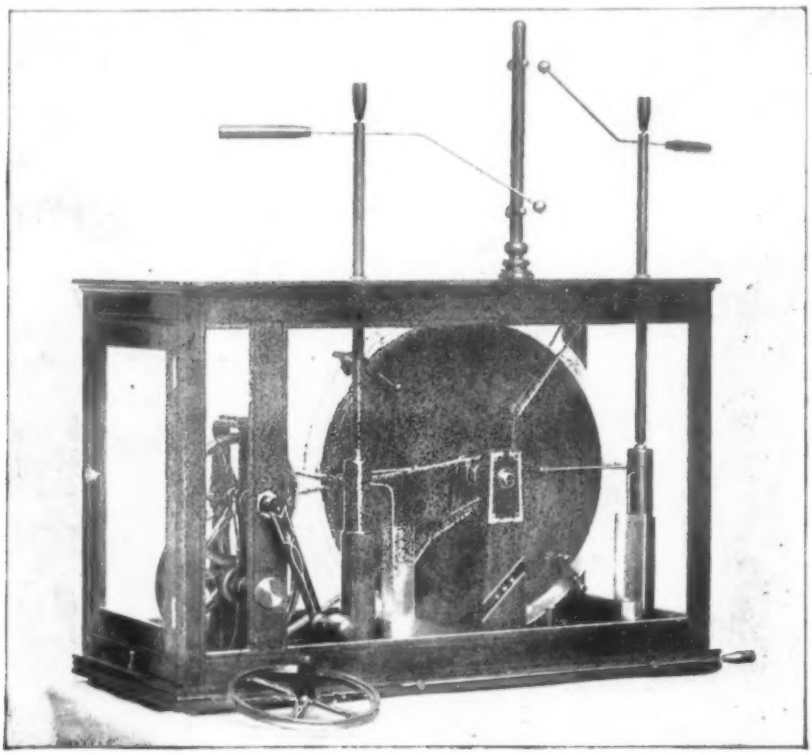

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